Folder Activity Chapter 12 Number 1 13 January 2016

Printed Name: Key

Chm 205 Student number: ______

1. The solubility of potassium bromide is 67.8 g per 100.0 g water at 25 °C. $MM = 119{,}0\,g/mol$

1a. Calculate the mole fraction for potassium bromide and for water for this solution.

	m	n
KBr	67,8 g	0,570 mol
H_2O	100 g	5,56 mol
Sol'n		

$$X = \frac{0{,}57}{5{,}56+0{,}57} = 0{,}0930$$

0,9070

1b. Calculate the mass percent for potassium bromide and for water for this solution.

$$\text{Mass\%} = 100 * \frac{67{,}8}{100+67{,}8}$$

$$= 40{,}4\ \%$$

1c. Calculate the molality of potassium bromide.

$$\text{molality} = \frac{n}{m(kg)} = \frac{0{,}570\ mol}{0{,}100\ kg}$$

$$= 5{,}70\ mol/kg$$

1d. Sketch the interaction between potassium ions and water. Sketch the interaction between bromide ions and water.

$K^+ \cdots :\ddot{O}-H$ with H

$Br^- \cdots H-\ddot{O}:$ with H

1e. Given $\Delta H_{sol'n}$ = +19.9 kJ/mol for the dissolving process, does the solution become warmer or cooler as potassium bromide dissolves? Write a chemical equation for the process that takes place.

Cooler

$KBr(s) \rightarrow KBr(aq)$

2. Strong ammonia solutions are 57 mass percent ammonia and have a density of 0.90 g/cm³. What is the molarity of ammonia for this solution?

	m	n	Vol
NH_3	57 g	$\boxed{3.35\ mol}$	
H_2O	43 g		
Sol'n	100 g		$\boxed{111\ mL}$

$MM = 17\,g/mol$

$d = \frac{m}{V}$ $V = \frac{m}{d}$

$$\text{Molarity} = \frac{3{,}35\ mol}{0{,}111\ L} = 30{,}15\ M$$

Questions in final exam format:

3. Iodine, $I_2(s)$, is more soluble in dichloromethane, CH_2Cl_2 (*l*), than in water because

A. both iodine and dichloromethane have strong ion-dipole interactions.

B. the dipole-dipole forces in dichloromethane are much stronger than the dispersion forces in iodine.

[✓ C.] the intermolecular forces are similar in both iodine and dichloromethane.

D. iodine is polar and dichloromethane has a large number of hydrogen bonds.

4. Commercial cold packs often contain solid NH_4NO_3 and a pouch of water. The temperature of the pack drops as the NH_4NO_3 dissolves in water. Therefore, for the dissolving of NH_4NO_3 in water,

A. $\Delta H_{sol'n}$ is negative and $\Delta S_{sol'n}$ may be negative or positive.

B. $\Delta H_{sol'n}$ is negative and $\Delta S_{sol'n}$ is positive.

[✓ C.] $\Delta H_{sol'n}$ is positive and $\Delta S_{sol'n}$ may be negative or positive.

D. $\Delta H_{sol'n}$ is positive and $\Delta S_{sol'n}$ is positive.

5. How much water must be added to 42.0 g of $CaCl_2$ (111 g/mol) to produce a solution that is 40.0 wt% $CaCl_2$? (Wt% and mass % are the same)

A. 56.7 g [✓ B.] 63.0 g

C. 16.8 g D. 120 g

$$\text{mass\%} = 100 * \frac{m_{CaCl_2}}{m_{CaCl_2} + m_{H_2O}}$$

$$40{,}0 = 100 * \frac{42}{(42 + m_{H_2O})}$$

$$m_{H_2O} = 63\ g$$

Folder Activity Chapter 12 Number 2 15 January 2016

Printed Name: Key

Chm 205 Student number: ______

1. Strong ammonia solutions are 57 mass percent ammonia and the rest water.

1a. What is the molality of ammonia for this solution? (Set up the little grid: mass and mole, solute and solvent. You can use it in 1b also.)

	MM	m	n
NH_3	17	57 g	3,35 mol
H_2O	18	43 g	2,39 mol

$$m = \frac{3,35\ mol}{0,043\ kg} = 78\ molal$$

1b. What is the mole fraction of ammonia for this solution?

$$X_{NH_3} = \frac{3,35}{3,35 + 2,39} = 0,584$$

2. $CHCl_3$ is a polar organic solvent with a vapor pressure of 205 mmHg at 25 ºC.

2a. Suppose 10.0 g $C_{10}H_8$ (MM = 128 g/mol), a non-volatile solute was dissolved in 50.0 g $CHCl_3$ (MM = 119.4 g/mol). What is the resulting vapor pressure?

	MM	m	n
$C_{10}H_8$	128	10g	0,0781 mol
$CHCl_3$	119,4	50g	0,419 mol

$$X_{CHCl_3} = 0,419/(0,419 + 0,0781)$$
$$= 0,84$$

$$P_{CHCl_3} = 0,84 * 205\ mmHg = 173\ mmHg$$

2b. CH_2Cl_2 has a vapor pressure of 421 mmHg at 25 ºC. What is the vapor pressure of solution that contains 0.28 mol CH_2Cl_2 and 0.43 mol $CHCl_3$?

$$X_{CH_2Cl_2} = 0,28/(0,28+0,43) = 0,394$$
$$X_{CHCl_3} = 0,606$$

$$P = 421\ mmHg * 0,394$$
$$+ 205\ mmHg * 0,606 =$$
$$290\ mmHg$$

Two volatile liquids

$$P_{soln} = P_AX_A + P_BX_B$$

3. The vapor pressure of water is 24.0 mmHg at 25 ºC. What is the vapor pressure of a solution containing 0.110 mol potassium sulfate in 100.0 g water?

$$100g\ H_2O = 5,56\ mol$$

$$X_{H_2O} = \frac{5,56\ mol}{3 * 0,110\ mol + 5,56\ mol} = 0,944$$

$$P_{soln} = 0,944 * 24,0 = 22,7\ mmHg$$

Questions in final exam format:

4. After methane, ethane, and propane, the next member of this series of hydrocarbons is butane, C_4H_{10}. Which statement is false?

A. Butane has a higher bp than propane.
B. Butanol has a higher bp than butane.
[✓ C.] Butane's boiling point is explained by hydrogen bonding.
D. Butanol has London dispersion forces and hydrogen-bonding.

5. Sodium hydroxide is available commercially as a 50.0% by weight aqueous solution. Calculate the molality of this sodium hydroxide solution.

A. 0.450 *m*
B. 19.1 *m*
[✓ C.] 25.0 *m*
D. 125. *m*

	MM	mass	n
NaOH	40	50g	1,25 mol
H_2O			
H_2O		50g	

$$m = \frac{1,25\ mol}{0,050\ kg} = 25,0\ m$$

6. The Henry's Law constant of methyl bromide, CH_3Br, is k = 0.159 mol/(L · atm) at 25 ºC. What is the solubility of methyl bromide in water at 25 ºC and at a partial pressure of 250. mmHg?

[✓ A.] 0.0523 mol/L
B. 0.329 mol/L
C. 0.483 mol/L
D. 39.8 mol/L

$$Sol = \frac{0,159\ mol}{L\ atm} * \frac{250}{760}\ atm$$
$$= 0,0523\ mol/L$$

7. A 2.00 M solution of $CaCl_2$ in water has a density of 1.17 g/mL. What is the mole fraction of $CaCl_2$?

A. 0.0348
B. 0.0360
[✓ C.] 0.0366
D. 0.0380

	MM	m	n	V
$CaCl_2$	111	222g	2,00 mol	
H_2O		948g →	52,7 mol	
Sol'n		1170g		1000 mL

$$X = \frac{2,00\ mol}{(2,00\ mol + 52,7\ mol)} = 0.0366$$

Classroom Activity Chapter 12 Number 3 18 January 2016

Printed Name: ______________________________ Chm 205 Student number: ______

1. Drinking water in the US cannot exceed 19 ppb lead (which is always in the form of Pb^{2+}). What is the molarity of lead ion, $[Pb^{2+}]$, in water that contains 19 ppb lead? Hint: Water's density is 1.0 g/cm^3.

	MM	mass, m	moles, n	Vol
Pb^{2+}	207 g/mol	19g	$\boxed{9,2\times10^{-2}}$	
H_2O	18 g/mol	1×10^9 g		$\boxed{1\times10^6}$ L

$$[Pb^{+2}] = \frac{9,2\times10^{-2}}{1\times10^{6}} = 9,2\times10^{-8}\ \frac{mol}{L}$$

2. Benzene, C_6H_6 has a relatively large freezing point depression constant, K_f = 5.07 deg/molal, making it a good solvent for freezing point lowering studies. The normal melting point of benzene is 5.53 °C. What is the molality of a solution that freezes at 1.25 °C?

$\Delta T_f = 5,07 * m$

$4,28 = 5,07 * m$

$m = 0,844$ molal

* 3. What is the ~~freezing~~ provided freezing point of water that contains 50.0 g $CaCl_2$ per kg of water? (Given: K_f = 1.86 deg/molal)

	MM	mass, m	moles, n
$CaCl_2$	111 g/mol	50g	$4,50\times10^{-1}$
H_2O	18 g/mol	1000	

$$\Delta T = 1,86\frac{deg}{molal} * \frac{4,50\times10^{-1}\ mol}{kg} * 3$$

$= 2,5$ deg $T_F = -2,5$ °C

4. $CHCl_3$ has a normal boiling point of 61.7 °C and a boiling point elevation constant, K_b = 3.63 deg/molal. When 2.00 g aspirin is dissolved in 50.0 g $CHCl_3$, the boiling point increases to 62.5 °C. What is the molar mass of aspirin?

$0,80$ deg $= 3,63\ m$

$m = 0,220$ mol/kg

$n = 0,220\frac{mol}{kg} * ,050\ kg = 1,1\times10^{-2}$ mol

MM = 182 g/mol

$\Delta T_b = K_b \cdot m \cdot i$

5. Ionic substances rarely have the van't Hoff factor predicted from the formula. What is the van't Hoff factor for a 0.50 *m* KCl(aq) solution if it freezes at a temperature of -1.1 °C? $K_f = 1,86$ deg/mol

~~i 1,1 deg = 1,86 * ,5 * i~~

1,9

FIX

Questions in final exam format:

6. What volume of 0.716 M KBr solution is needed to provide 13.0 g of KBr?

A. 6.55 mL

B. 9.31 mL

C. 18.5 mL

[✓ D. 153 mL]

$$V = \frac{13,0\ g}{} \Big| \frac{L}{0,716\ mol} \Big| \frac{mol}{119\ g}$$

$n = M \cdot V$

$V = \frac{n}{M}$

7. Which of the following solutions will have the **lowest** freezing point?

A. 0.0100 *m* NaCl $i = 2$

B. 0.0120 *m* Li_2SO_4 $i = 3$

C. 0.0400 *m* $CH_3CH_2CH_2OH$ $i = 1$

[✓ D. 0.0150 *m* $MgCl_2$] $i = 3$

$\Delta T_f = K_f \cdot m \cdot i$

8. Calculate the freezing point of a solution of 50.0 g methyl salicylate, $C_7H_6O_2$, dissolved in 800. g of benzene, C_6H_5. K_f for benzene is 5.10°C/*m* and the freezing point is 5.50 °C for benzene. MM = 122 g/mol

A. -2.61°C

B. 2.61°C

[✓ C. 2.89°C]

D. 8.39°C

$n = \frac{50}{122} = 0,410$ mol

$m = 0,512$ molal

$\Delta T = 5,10\frac{deg}{molal} * 0,512$ molal $= 2,61$ deg

9. When 0.500 g of vitamin K is dissolved in 10.0 g of camphor (K_f = 40.0 °C/*m*), the freezing point of the solution is 4.43 °C lower than that of pure camphor. Assuming vitamin K is a nonelectrolyte in camphor, calculate its molar mass.

A. 0.451 g/mol

B. 55.4 g/mol

[✓ C. 451 g/mol]

D. 3.54 × 10^4 g/mol

$4,43 = 40 * m$

$m = 0,111$ molal

$n = 1,11\times10^{-3}$ mol

MM = 451

Classroom Activity Chapter 12 Number 4 20 January 2016

Printed Name: ______________________________ Chm 205 Student number: ______

1. Circle the member of each pair with the higher predicted boiling point.
   - A. ethane OR [✓ propane]
   - B. ethane OR [✓ propanol]
   - C. methane OR [✓ methanal]
   - D. propane OR [✓ propanoic acid]
   - E. methane OR [✓ methyl amine]

2. Predict the value for i for each of these aqueous solutions.
   - A. 0.20 molal potassium nitrate 2
   - B. 0.10 M HCl(aq) 2
   - C. $X_{glucose} = 0.220$ 1
   - D. 2.26 mass% sodium sulfate 3
   - E. $[CH_2O] = 0.117$ molal

3. What is the osmotic pressure of a ~~1.50~~ M 0.150 ammonium perchlorate solution?

$\pi = MRTi$

$= 0.150 * .0821 * 298 * 2$

$= 7,3$ atm

4. A solution was prepared by dissolving 20.0 g of an unknown carbohydrate ($C_xH_yO_z$) in 50.0 g water and determining the freezing point of the solution to be -2.17 °C. What is the molar mass of the unknown? Given: $K_f = 1.86$ deg/molal

$\Delta T = 2,17 = 1,86 * m * 1$

$m = 1,17$ mol/kg

$n = \frac{1.17 \text{ mol}}{kg} * .05$ kg

$= 0,058$ mol

$MM = \frac{20.0g}{.058} = 343$ g/mol

5. A nitrate salt, thought to be $LiNO_3$, $NaNO_3$, KNO_3, $RbNO_3$ or $CsNO_3$, was dissolved in water. When 4.75 g of the salt was dissolved in water to make 100.0 mL solution, the osmotic pressure was determined to be 23 atm at 25 °C. What is the identity of the salt? What flame test color would you expect?

$23 = M \cdot ,0821 \cdot 298 \cdot 2$

$M = 0,47$ mol/L

$n = 0,047$ mol

$MM = 101,0$ g/mol KNO_3

Questions in final exam format:

6. When ethylene glycol, $HOCH_2CH_2OH$, is added to the water in an automobile radiator, the effect is to
   - A. lower the boiling point and lower the freezing point.
   - B. lower the boiling point and raise the freezing point.
   - [✓ C.] raise the boiling point and lower the freezing point.
   - D. raise the boiling point and raise the freezing point.

7. The coolant in automobiles is often a 50/50 % by volume mixture of ethylene glycol, $HOCH_2CH_2OH$, and water. At 20°C, the density of ethylene glycol is 1.1088 g/mL and the density of water is 0.9982 g/mL. Assuming that the volumes are additive, what is the expected freezing point of a 50/50(v/v)% ethylene glycol/water solution? K_f = 1.86°C/*m* for water.

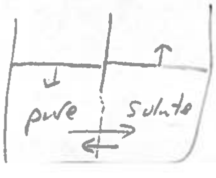
62 g/mol

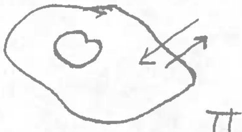
   - A. -16 °C
   - B. -17 °C
   - C. -30 °C
   - [✓ D.] -33 °C

$n_{EG} = 50mL * 1,108 \frac{g}{mL} * \frac{mol}{62g}$

$= \frac{0,89 \text{ mol}}{0,050 * 0,9982} * 1.86$

8. Red blood cells are placed into pure water. Which of the following statements is true?
   - A. Water molecules flow out of the red blood cells, causing them to collapse.
   - [✓ B.] Water flows into the red blood cells, causing them to swell and burst.
   - C. The osmotic pressure of the cell contents increases, causing the cells to burst.
   - D. The osmotic pressure inside the cells equals the osmotic pressure outside.





$\pi = MRTi$

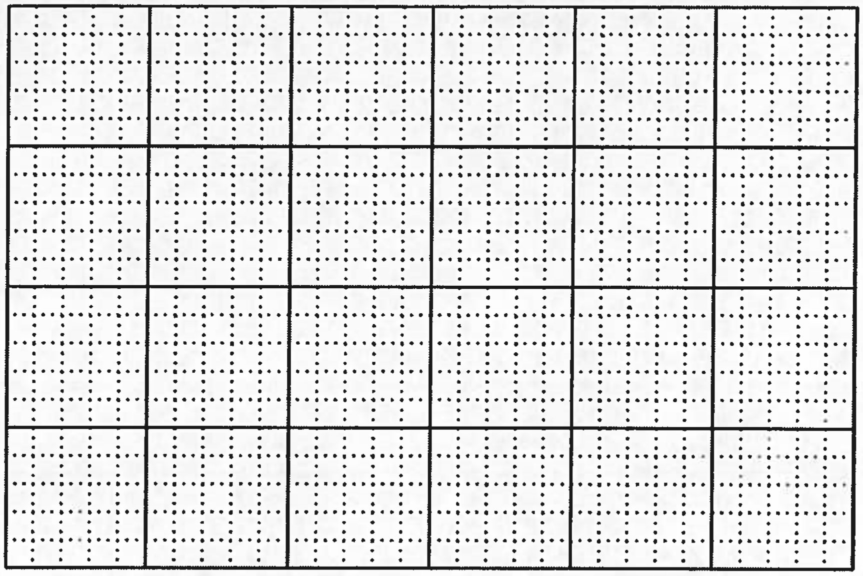
Classroom Activity Chapter 13 Number 1 22 January 2016

Printed Name: ______________________________ Chm 205 Student number: ______

$$2\ N_2O_5(g) \rightarrow 4\ NO_2(g) + O_2(g)$$

time	$[N_2O_5]$	$[NO_2]$	$[O_2]$
0 s	2.330 mol/L	0	0
1000 s	1.260		
2000 s	0.681		
3000 s	0.369		
4000 s	0.199		

1. Graph these data with time on the x-aaxis and $[N_2O_5]$, $[NO_2]$, and $[O_2]$ on the y-axis.



done in class

2. Sketch a tangent line on the graph and estimate the rate at t = 1000 s in terms of rate = $-\Delta[N_2O_5]/\Delta t$. Make sure to use the right units.

R= ,0154

$rate = \frac{\Delta[N_2O_5]}{\Delta t} = 0,036 \frac{mol\ N_2O_5}{L \cdot s}$

done in class

3. Using your value from Question 1, what is the rate in terms of rate = $\Delta[NO_2]/\Delta t$ and rate = $\Delta[O_2]/\Delta t$

$rate = \frac{0,035\ mol\ N_2O_5}{L \cdot s} \left| \frac{1\ mol\ O_2}{2\ mol\ N_2O_5} \right.$

$= 0,018\ mol\ O_2/L \cdot s$

4. Is this reaction [✓ slowing down] or speeding up with time?

5. Would the rate of the reaction [✓ increase] or decrease if one started with a larger $[N_2O_5]$?

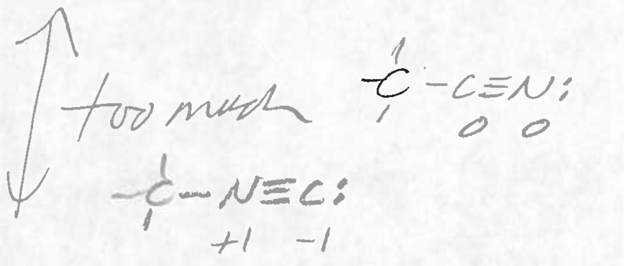
Classroom Activity Chapter 13 Number 2 25 January 2016

Printed Name: ______________________ Chm 205 Student number: ______

1. Consider this reaction in which the nitrogen atom rearranges:

$$CH_3NC \rightarrow CH_3CN$$

1a. Sketch a Lewis dot structure for both reactant and product. Assign formal charges to each atom.



1b. Use this data to determine the order of the reaction and the value of the rate constant with proper units. Write the rate expression (law).

	Initial $[CH_3NC]$ mol/L	Initial rate = $-\Delta[CH_3NC]/\Delta t$ mol/Ls
Expt 1	0.0439	2.24×10^{-6}
Expt 2	0.0394	2.01×10^{-6}
Expt 3	0.0722	3.69×10^{-6}

$$\frac{2.24\times10^{-6}}{3.69\times10^{-6}} = \left(\frac{0.0439}{0.0722}\right)^x$$

$$.607 = .608^x$$

1st order rate $= k[CH_3NC]^1$

$k = 5.10 \times 10^{-5}\ s^{-1}$

1c. What is the rate, with proper units, if $[CH_3NC]$ = 0.100 M?

rate $= 5.10\times10^{-5}\ s^{-1} * 0.10$ mol/L

$= 5.10 \times 10^{-6}$ mol/L s

1d. Express the rate in terms of rate = $+\Delta[CH_3CN]/\Delta t$

rate $= 5.10\times10^{-6}$ mol/L s

−10 ←

1e. Use the appropriate time concentration expression to determine what the concentration will be after 1.00 hours.

4 $[CH_3NC]_{t=0} = 0.100$ M

$$\ln\left(\frac{0.100}{[A]_t}\right) = 5.10\times10^{-6}\ \frac{mol}{L\,s} * 3600\ s$$

$$\frac{0.100}{[A]_t} = 1.202$$

0.0832 M

$[A]_t =$ ~~0.098~~

2. Consider the reaction of 2 HI(g) → $H_2(g) + I_2(g)$. Use this data to determine the order of the reaction and the value of the rate constant with proper units. Write the rate expression (law).

Time (hr)	[HI]
0	0.1000
12	0.0960
24	0.0888
36	0.0799
48	0.0705

.004
.0072
.0089

!

ln		1/	
−2.303		10,000	
	.040		.42
−2.343		10,417	
	.078		.84
−2.421		11,261	
	1.06		1.255
−2.527		12,516	

Questions in final exam format:

3. The decomposition of ammonia to nitrogen and hydrogen on a tungsten filament at 800°C is independent of the concentration of ammonia at high pressures of ammonia. What is the order of the reaction with respect to ammonia?

[✓ A. zero] B. first C. second D. third

4. Using the method of initial rates for the reaction A → B, if the initial concentration of A is doubled and the rate of reaction quadruples, what is the order of reaction with respect to A?

A. zero B. first [✓ C. second] D. fourth

5. The first-order decomposition of hydrogen peroxide occurs according to the equation

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

Which plot will produce a straight line?

A. $[H_2O_2]$ versus time B. $[H_2O_2]_2$ versus time

C. $1/[H_2O_2]$ versus time [✓ D. $\ln[H_2O_2]$ versus time]

Classroom Activity Chapter 13 Number 3 27 January 2016

Printed Name: ______________________________ Chm 205 Student number: ______

1. The following data were presented in the previous worksheet and led to the conclusion that the best fit was for second order.

$$2\,HI(g) \rightarrow H_2(g) + I_2(g).$$

Use this data to determine the value of the rate constant with proper units. Write the rate expression (law).

Time (min)	[HI]
0	0.1000
100	0.0741
200	0.0588
$\underline{300}$	0.0488
400	0.0417
500	0.0364

$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

$$\frac{1}{0.0488} = k\,300 + \frac{1}{0.10}$$

$$k = 0.0350 \frac{L}{mol\,K}$$

1a. How long does it take for [HI] = 0.0600 M?

$$\frac{1}{0.06} = .0350\,t + \frac{1}{0.10}$$

$$t = 190 \text{ min}$$

1b. What is [HI] after 600 min?

$$\frac{1}{[A]_t} = .0350 \cdot 600 + 1/0.10$$

$$[A]_t = 0.0323 \text{ M}$$

2. A first-order reaction has a half-life of 37.0 min. How long does it take for the initial concentration of reactant, A, to decrease by 80% from its original concentration?

$$t_{1/2} = 0.693/k$$

$$k = 0.693/37 \text{ min}$$

$$0.0187 \text{ min}^{-1}$$

$$\ln\left(\frac{100}{20}\right) = 0.0187\,t$$

$$t = 85.9 \text{ min}$$

3. A first-order reaction decreases from 0.0500 M to 0.0400 M in 24.4 minutes. What is its half life?

$$\ln\left(\frac{.05}{.04}\right) = k\,24.4 \text{ min}$$

$$k = 9.145 \times 10^{-3}$$

$$t_{1/2} \approx 75.8 \text{ min}$$

4. Consider the reaction:

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

The rate constant increases with temperature as summarized here. Use the Arrhenius equation to calculate the energy of activation for this reaction.

Temperature	k (L/mol s)
330 °C 603	0.77
354 °C 627	1.8
383 °C	4.7

$$\ln(k_2/k_1) = (-E_a/R)(1/T_1 - 1/T_2)$$

$$\ln\left(\frac{1.8}{.77}\right) = \left(\frac{-E_a}{8.314}\right)\underbrace{\left(\frac{1}{603} - \frac{1}{627}\right)}_{6.348\times10^{-5}\ \checkmark}$$

$$0.849 = \frac{-E_a}{8.314} \qquad 1.66\times10^{-3} - 1.59\times10^{-3}$$

$$111 \text{ kJ/mol}$$

Questions in final exam format:

5. What is the minimum energy barrier that must be overcome for a chemical reaction to occur?

[✓ A.] activation energy B. net energy

C. potential energy D. rate limiting energy

6. When the temperature of a gas whose activation energy is 55 kJ/mol is increased from 300 K to 320 K, the fraction of collisions with sufficient energy to react…

A. decreases by a factor of 2.

B. decreases by a factor of 4.

C. increases by a factor of 2.

D. increases by a factor of 4.

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{-55000}{8.314} * \left(\frac{1}{300} - \frac{1}{320}\right)$$