

### Quiz 1-Freebie

#### Quiz 2

1. Name the following, using Stock notation, if appropriate.
  - a)  $\text{KNO}_2$
  - b)  $\text{CoSO}_4$
2. Give formulas for the following
  - a) carbon tetrachloride
  - b) chromium(III) cyanide
3. A system gains 30KJ of heat while performing 65KJ of work on the surroundings. What is  $\Delta E$ ?
4. What is  $q$  if 24.5g of iron(s) undergo a temperature change from  $78^\circ$  to  $214^\circ$ ?

#### Quiz 3

1. Give formulas for the following
  - a) sodium carbonate
  - b) iron(II) phosphate
2. Name the following, using Stock notation, **if needed**.
  - a)  $\text{CS}_2$
  - b)  $\text{Ir}(\text{NO}_3)_3$
3. A sample of metal with a mass of 14.3g at a temperature of  $215^\circ\text{C}$  is dropped into 100.0g of water at  $25.0^\circ\text{C}$ . The final temperature is found to be  $30.0^\circ\text{C}$ . What is the specific heat of the metal?

#### Quiz 4

1. Name the following, using Stock Notation, **as needed**.
  - a)  $\text{Cu}_2\text{SO}_4$
  - b)  $\text{XeF}_4$
2. Give formulas for the following
  - a) nickel(II) perchlorate
  - b) calcium oxide
2. A sample of gas has initial  $P$  and  $V$  of 230torr and 0.36L. If the pressure is changed to 1.72atm, what is the resultant volume in mL?

### Quiz 5-Freebie

#### Quiz 6

1. What is the molarity of a solution prepared by dissolving 12.3g of potassium nitrate in a total volume of 250.0mL
2. The heat of fusion of water is 6.01KJ/mole. What is the heat change for the melting of 1.26g of ice?

#### Quiz 7

1. A compound consisting of a metal and oxygen has the unit cell shown project on the screen in the front of the room. If you have v1 of this quiz-use the structure on the left screen. If you have v2-use the structure on the right screen.. In both compounds, the oxygens are the white spheres. Determine the number of each type of atom, metal and oxygen in the unit cell and from that give the formula of the compound.
2. Using the information on your periodic table and the fact that the constant for simple cubic is 0.1250, calculate the density of nickel if it were simple cubic.

#### Quiz 8

1. For each of the following, indicate what the **strongest** intercomponent force would be.
  - a) barium iodide
  - b)  $\text{CH}_3\text{CHO}$
  - c)  $\text{C}_3\text{H}_7\text{NH}_2$
  - d)  $\text{Si}(\text{s})$
  - e) motor oil

2. For the following molecules, indicate whether you would expect it to have a permanent dipole and, if so, indicate the approximate direction of the dipole. You may have to sketch the structure to answer the question.

a) xenon tetrafluoride

b)  $\text{BCl}_2\text{F}$

### Quiz 9

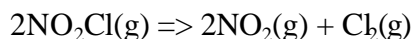
1. A solution contains 46g of water ( $P^\circ=123\text{torr}$ ), and 0.20moles of a nonvolatile solute. Assuming that the solute does not dissociate, what would the vapor pressure of the solution be?

2. A solvent has  $T_f=23.4^\circ\text{C}$  and  $K_f=0.673\text{deg}/m$ . What would the freezing point be for a solution prepared by dissolving 0.34moles of a nondissociating solute in 85.4g of solvent?

### Quiz 10-Freebie

### Quiz 11

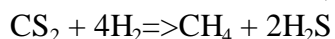
1. The reaction below is first order in  $\text{NO}_2\text{Cl}$  with a rate constant of  $0.037\text{sec}^{-1}$ .



a) What is the half-life of the reaction?

b) If the initial concentration of  $\text{NO}_2\text{Cl}$  is  $0.010\text{M}$ , what is the concentration after 1.00minutes?

2. Given the reaction shown below,



if the reaction rate for  $\text{H}_2$  is  $-1.6\text{M}\cdot\text{sec}^{-1}$ , what are the rates for the other compounds?

### Quiz 12

Show your work on all problems requiring calculations(no work=no points)

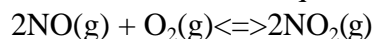
1. For each of the following, write the proper form of  $Q_{\text{rxn}}$ .

a)  $2\text{CO}(\text{g}) \rightleftharpoons \text{C}(\text{s}) + \text{CO}_2(\text{g})$

b)  $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$

c)  $2\text{Fe}(\text{s}) + 3\text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{Fe}_2\text{O}_3(\text{s}) + 3\text{H}_2(\text{g})$

2. Given the balanced equation and the equilibrium concentrations shown:



Equilibrium Concentrations:

$\text{NO}:0.30\text{M}$

$\text{O}_2:0.11\text{M}$

$\text{NO}_2:0.076\text{M}$

What is the value of  $K$ ?

### Exam 1-v1

$\frac{1}{2}$

1. Name the following, using Stock Notation **only if necessary**.(1 point ea)

a)  $\text{MgSO}_3$

b)  $\text{ClF}_3$

c)  $\text{MnCO}_3$

d)  $\text{Co}(\text{CN})_3$

2. Give formulas for the following(1 point ea)

a) iron(II) iodide

b) sulfur trioxide

c) vanadium(II) permanganate

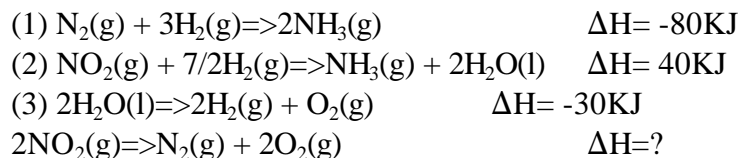
d) dinitrogen tetraoxide

3. Is it possible for a 0.250kg sample of cobalt with an initial temperature of  $178^\circ\text{C}$  to lose 8.90KJ of heat? Explain your answer. (6 pts)

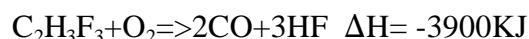
4. You have 172g sample of water at  $94.3^\circ\text{C}$ . How many grams of water at  $21.3^\circ\text{C}$  would you have to add such that the final temperature was  $42.3^\circ\text{C}$ ?(6pts)

5. A system performs 23.4J of work while absorbing 62.3J of heat. What is  $\Delta E$ ?(4 pts)

6. A sealed gas system at 46°C and a pressure of 530torr undergoes a change of temperature at constant volume to a pressure of 1.47atm. What is the **temperature change** in K?(6 pts)
7. Assume you have a sample of gas in a **constant volume** container. Is it possible for **increases in both P and n** to result in an **overall decrease in T**. Explain your reasoning.(8 pts)
8. Use the equations shown below to determine the enthalpy for the final reaction.(8 pts)



9. A sample of nitrogen effuses at a rate of 150torr /sec. At what rate would oxygen would effuse under the same conditions?(6 pts)
10. The following two questions deal with the thermochemical equation:



- a) What is  $\Delta H$  for the reaction of 16.3 g of  $\text{C}_2\text{H}_3\text{F}_3$ ?(4 pts)
- b) How many moles of HF would be produced in a reaction where  $\Delta H$  were -740KJ?(4 pts)
11. Write gas law “change of state” equation which relates **n,T and V** under conditions of **constant P**. Explain how you derived your law.(6 pts)
12. A system undergoes a change of state (State 1  $\Rightarrow$  State 2) while performing 100KJ of work on the surroundings. The surroundings then perform 150KJ of work on the system, returning it to the initial state (State 2  $\Rightarrow$  State 1). Is this permitted or does it violate the First Law? Explain your answer.(6 pts)
13. Use the heats of formation provided (back page) to determine the enthalpy for the reaction below.(8 pts)
- $$4\text{NH}_3(\text{g}) + 7\text{O}_2(\text{g}) \Rightarrow 4\text{NO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$$
14. Estimate the volume of 2.55moles of gas at a temperature of 300°C, and a pressure of 0.250torr. Briefly explain how you arrived at your answer without presenting any calculations beyond mental estimates.(6 pts)
15. A mixture of gases contains 23.4g of chlorine, 21.4g of Ar and 27.4g of  $\text{CH}_3\text{Cl}$ . If the partial pressure of the argon is 150torr, what are the partial pressures of the other two gases?(8 pts). What additional information would be needed to calculate the temperature of the system?
16. Briefly define any three of the following (**Do only 3**)(2pts ea)

- a)  $q_v$
- b) b in the van der Waals equation
- c) state function
- d) a in the van der Waals equation
- e) enthalpy

### Exam 1-v2

1. Name the following, using Stock Notation **only if necessary**.(1 point ea)
- a)  $\text{MgSO}_3$
- b)  $\text{ClF}_3$
- c)  $\text{MnCO}_3$
- d)  $\text{Co}(\text{CN})_3$
2. Give formulas for the following(1 point ea)
- a) iron(II) iodide
- b) sulfur trioxide

c) vanadium(II) permanganate

d) dinitrogen tetraoxide

3. Is it possible for a 0.350kg sample of nickel with an initial temperature of 162°C to lose 7.30KJ of heat? Explain your answer. (6 pts)

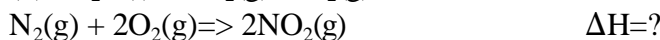
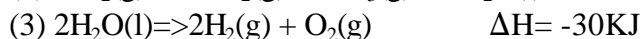
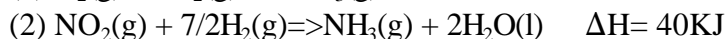
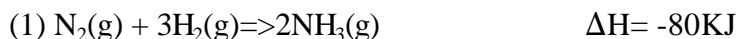
4. You have 152g sample of water at 91.3°C. How many grams of water at 28.9°C would you have to add such that the final temperature was 46.4° C?(6pts)

5. A system performs 53.4J of work while losing 52.3J of heat. What is  $\Delta E$ ?(4 pts)

6. A sealed gas system at 73°C and a pressure of 0.630atm undergoes a change of temperature at constant volume to a pressure of 1130torr. What is the **temperature change** in K?(6 pts)

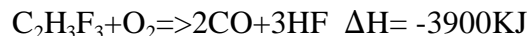
7. Assume you have a sample of gas in a **constant volume** container. Is it possible for **decreases in both P and n** to result in an **overall increase in T**. Explain your reasoning.(8 pts)

8. Use the equations shown below to determine the enthalpy for the final reaction.(8 pts)



9. A sample of oxygen effuses at a rate of 120torr/sec. At what rate would nitrogen would effuse under the same conditions?(6 pts)

10. The following two questions deal with the thermochemical equation:



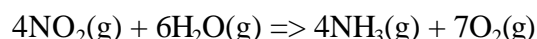
a) What is  $\Delta H$  for the reaction of 27.8 g of  $\text{C}_2\text{H}_3\text{F}_3$ ?(4 pts)

b) How many moles of CO would be produced in a reaction where  $\Delta H$  were -640KJ?(4 pts)

11. Present a gas law “change of state” equation which relates **n,T and P** under conditions of **constant V**. Explain how you derived your law.(6 pts)

12. A system undergoes a change of state (State 1  $\Rightarrow$  State 2) while performing 100KJ of work on the surroundings. The surroundings then perform 150KJ of work on the system, returning it to the initial state (State 2  $\Rightarrow$  State 1). Is this permitted or does it violate the First Law? Explain your answer.(6 pts)

13. Use the heats of formation provided (back page) to determine the enthalpy for the reaction below.(8 pts)



14. Estimate the volume of 2.55moles of gas at a temperature of 300°C, and a pressure of 0.250torr. Briefly explain how you arrived at your answer without presenting any calculations beyond mental estimates.(6 pts)

15. A mixture of gases contains 13.4g of chlorine, 17.4g of Ar and 14.4g of  $\text{CH}_3\text{Cl}$ . If the partial pressure of the  $\text{CH}_3\text{Cl}$  is 230torr, what are the partial pressures of the other two gases?(8 pts). What additional information would be needed to calculate the volume of the system?

16. Briefly define any three of the following (**Do only 3**)(2pts ea)

a)  $q_v$

b) b in the van der Waals equation

c) state function

d) a in the van der Waals equation

e) enthalpy

## Exam 1 Answers

Problems 1 and 2 were nomenclature

3. If one calculates the  $\Delta T$  resulting from the loss of the heat given, the solution becomes clear

**v1:**  $\Delta T = 8900 / (250 * .421) = 84.5^\circ$  above abs zero so it's possible

**v2:**  $\Delta T = 7300 / (350 * .444) = 47^\circ$  above abs zero so it's possible

4.  $q_{\text{lost}} = -q_{\text{gain}}$   $(C_s * m * \Delta T)_{\text{hot}} = -(C_s * m * \Delta T)_{\text{cold}}$   $m_{\text{cold}} = (C_s * m * \Delta T)_{\text{hot}} / -(C_s * \Delta T)_{\text{cold}}$   $C_s$  can be dropped

**v1:**  $172 * (42.3 - 94.3) / -(42.3 - 21.3) = 425\text{g}$

**v2:**  $152 * (46.4 - 91.3) / -(46.4 - 28.9) = 390\text{g}$

5.  $\Delta E = q + w$

**v1:**  $\Delta E = 62.3 - 23.4 = 38.9\text{J}$

**v2:**  $\Delta E = -52.3 - 53.4 = -105.7\text{J}$

6. P & T direct  $(T_1/P_1) * P_2 = T_2$   $\Delta T = T_2 - T_1$

**v1:**  $T_1 = 319\text{K}$   $P_1 = 530\text{torr}$   $P_2 = 1117\text{torr}$   $(319/530) * 1117 = 672\text{K}$   $672 - 319 = 353\text{K}$

**v2:**  $T_1 = 346\text{K}$   $P_1 = 0.63\text{atm}$   $P_2 = 1.49\text{atm}$   $(346/.63) * 1.49 = 816\text{K}$   $816 - 346 = 470\text{K}$

7. **v1:** P & T direct; n & T inverse. If the change in n is higher proportionally than that in P than an overall decrease will occur.

**v2:** P & T direct; n & T inverse. If the change in n is higher proportionally than that in P than an overall increase will occur.

8.

**v1:** Need Dir Qty

1) N<sub>2</sub> R +80 x1 80

2) NO<sub>2</sub> ok 40 x2 80

3) O<sub>2</sub> ok -30 x2 -60

total 100KJ

**v2:** Need Dir Qty

1) N<sub>2</sub> ok -80 x1 -80

2) NO<sub>2</sub> R -40 x2 -80

3) O<sub>2</sub> R 30 x2 60

-100KJ

9.  $\text{rate}_1 / \text{rate}_2 = \sqrt{g_{\text{mw}2}} / \sqrt{g_{\text{mw}1}}$   $\text{rate}_2 = \text{rate}_1 * \sqrt{g_{\text{mw}1}} / \sqrt{g_{\text{mw}2}}$

**v1:** N<sub>2</sub>=28 O<sub>2</sub>=32  $\text{rate}_2 = 150(5.29/5.66) = 140\text{torr/sec}$  O<sub>2</sub> should be slower

**v2:** N<sub>2</sub>=28 O<sub>2</sub>=32  $\text{rate}_2 = 120(5.66/5.29) = 128\text{torr/sec}$  N<sub>2</sub> should be faster

10. **v1:** a)  $(-3900/84) * 16.3 = -756\text{J}$  b)  $(3/-3900) * -740 = 0.57\text{moles}$

**v2:** a)  $(-3900/84) * 27.8 = -1290\text{KJ}$  b)  $(2/-3900) * -640 = 0.33\text{moles}$

11. **v1:** n \* V direct T & V direct  $(n_1 * T_1 / V_1) = (n_2 * T_2 / V_2)$

**v2:** same as v1

12. **v1 and v2:** Yes-the first law only requires that  $\Delta E = 0$  so as long as q balances out the w values, it's permitted

13.  $q = \sum \Delta H_{\text{prods}} - \sum \Delta H_{\text{reacts}}$  heat of formation of O<sub>2</sub> (an element) is 0 by definition

**v1:**  $q = 6 * \text{H}_2\text{O} + 4 * \text{NO}_2 - 4 * \text{NH}_3 - 6 * -241.8 + 4 * 33.2 - 4 * -46.1 = -1134\text{KJ}$

**v1:**  $q = 4 * \text{NH}_3 - (6 * \text{H}_2\text{O} + 4 * \text{NO}_2) - 4 * -46.1 - (6 * -241.8 + 4 * 33.2) = 1134\text{KJ}$

14. Many possible approaches-one will be given-comparing conditions with STP

1mole, 22.4L, 1atm, 273K

**v1:** moles(20\*2.5) => 50L P is 1/4 so quadruple V to 200L T is double so x2 = 400L

**v2:** same as v1:

15. gmws Cl<sub>2</sub>:70.9, Ar: 40, CH<sub>3</sub>Cl:50.5

v1: Moles Cl<sub>2</sub>: 23.4/71=0.33 Ar: 21.4/40=0.53 CH<sub>3</sub>Cl 27.4/50.5=0.54 nT=

Xs Cl<sub>2</sub> 0.24 Ar: 0.38 CH<sub>3</sub>Cl 0.38

PT is gotten from PAr and its X PT=150/.38=395

Ps Cl<sub>2</sub>=395\*0.24=95 Ar: 150 CH<sub>3</sub>Cl 395\*0.38=150

In order to calculate T, you'd need the volume

v2: Moles Cl<sub>2</sub>: 13.4/71=0.19 Ar: 17.4/40=0.44 CH<sub>3</sub>Cl 14.4/50.5=0.29 nT=0.92

Xs Cl<sub>2</sub> 0.21 Ar: 0.48 CH<sub>3</sub>Cl 0.31

PT is gotten from PCH<sub>3</sub>Cl and its X PT=230/.31=740

Ps Cl<sub>2</sub>=740\*0.21=155 Ar: 740\*.48=355 CH<sub>3</sub>Cl 230

In order to calculate T, you'd need the volume

16. Refer to notes or text for the definitions

### Exam 2

1. A solution is prepared by dissolving 12.4 of calcium nitrate in a total volume of 100.0mL. What would the osmotic pressure be at 22°C?(8 points)

2. Answer **one** of the following( **do only one!!!**)(5 points)

a. Briefly explain why the density of the unit cell **must be equal to** the density of the material.

b. Briefly present your version of the Second Law of thermodynamics

3. A solution of 3.02 grams of solute in 58.7 grams of a solvent( $K_f=5.39\text{deg/molal}$ ;  $T_f=99.2^\circ\text{C}$ ) is found to have a freezing point of  $96.7^\circ\text{C}$ . What is the solute's molecular weight?(8 points)

4. For each of the following indicate the primary intercomponent force(5 points)

a) (CH<sub>3</sub>)<sub>2</sub>NH

b) potassium iodide

c) helium

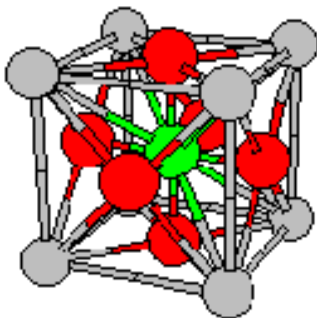
d) CH<sub>3</sub>F

e) Si(s)

5. A mixture contains diethylether( $P^\circ=429\text{torr}$ ) and ethanol( $P^\circ=51.4\text{torr}$ ), both of which are volatile. If the vapor pressure of the ethanol is found to be 34.5torr, what is the vapor pressure(torr) of diethyl ether?(8 points)

6. In the space below, sketch and **label completely** the phase diagram for **water**(8 points)

7. The unit cell shown below is for a compound containing Ca(black), Ti(light gray) and O(dark gray). Determine the number of atoms for each element in the unit cell (show the values you obtain) and the resultant formula for the compound.(6 points)



8. A 35.4g ice cube at 0°C is dropped into 56.3g of water at 34.0°C. Will the ice cube melt completely? Make sure you present the necessary calculation to support your answer.(8 points)

9. What would the density of cobalt be if it were bodycentered cubic?(6 points)
10. What is the sodium ion concentration in a solution prepared by dissolving 19.6g of sodium carbonate in a total volume of 150.0mL (6 points)
12. Below are ten statements, **at least** five of which are correct. Identify five correct statements and circle the letter at the start of the statement. Two points for each correct identification and -1 if you identify an incorrect statement as correct and -2 for each extra response if more than five are circled. Thus, don't make random choices.(10 points)
- A. An ideal solution is one which follows Raoult's Law exactly.
- B. The triple point represents the minimum pressure where the liquid can exist.
- C. The hydrogen bond is stronger than a London dispersion force.
- D. Osmosis is flow of solvent from a region of high to low solute concentration.
- E. Silicon dioxide is an example of a network solid
- F. The NaCl lattice is an example of simple cubic structure.
- G. Ebullition is the rapid growth of solid crystals at the freezing point.
- H. The van't Hoff factor helps determine the density of crystals.
- I. A change of state for which  $\Delta H$  and  $\Delta S$  are both positive will go from nonspontaneous to spontaneous as the temperature is increased.
- J. Miscible means that two substances form homogeneous mixtures in all proportions

13. Using the kinetics data below, first determine the orders for A, B, and C. Once the orders are correct, determine the value of the rate constant. You must present the method whereby you obtained the rate law.(8 points)

	[A]	[B]	[C]	Rate(M/sec)
Trial 1	1.50	.100	0.050	$7.9 \times 10^{-8}$
Trial 2	1.50	.100	0.15	$7.1 \times 10^{-7}$
Trial 3	0.500	.050	0.050	$2.6 \times 10^{-8}$
Trial 4	1.50	.0500	0.050	$7.9 \times 10^{-8}$

14. For a solution of two volatile materials, you are given  $P_A^\circ$ ,  $P_B^\circ$ , and  $P_A$ . Present the path you would follow to calculate  $X_{B(\text{vapor})}$ .(8 points)

15. If the heat of vaporization for a compound is 0.58KJ at 67.3°C, what is its entropy of vaporization? (6 points)

### Exam 2 Answers

1.  $\text{Ca}(\text{NO}_3)_2$  gfw=164g/mole  $n=12.4/164=0.0756$   $M=0.0756/.1=0.756\text{M}$

You get 3 ions so the effective concentration is  $3 \times 0.756$

$$\Pi = M \cdot R \cdot T = (3 \times 0.756) \times 0.082 \times 295\text{K} = 54.8\text{atm}$$

2. a) the unit cell is a defining piece of the bulk and must have all of properties of the whole, including its density.

b) looking for something beyond pure rehash of what you'd read or heard.

3.  $\Delta T_f = K_f \cdot m$   $\Delta T_f = 96.7 - 99.2 = -2.5^\circ$ .  $m = \Delta T_f / K_f = 2.5 / 5.39 = 0.46$   $0.46 = n/\text{kg}$   $n = 0.46 \times 0.0587 = 0.027$   
gfw =  $3.02 / 0.027 = 111.8\text{g}$

4. a) hydrogen bond b) ion-ion c) London dispersion d) dipole-dipole e) covalent (network solid)

5.  $X_{\text{ethanol}(\text{liq})} = 34.5 / 51.4 = 0.67$   $X_{\text{ether}(\text{liq})} = 1 - 0.67 = 0.33$   $P_{\text{ether}} = 0.33 \times 429 = 141\text{torr}$

6. See text page 414 figure 10.28

7. 1 Ca in the center-counts as 1; 8 Ti in corners  $(8 \times 1/8)=1$  ; 6 oxygens in faces  $(6 \times 1/2)=3$   
CaTiO<sub>3</sub>

8.  $n_{\text{ice}}=35.4/18=1.97$  moles  $q_{\text{melt}}=1.97 \times 6010\text{J}=11800\text{J}$

The warm water going from 34.0 to 0  $\Rightarrow q=56.3 \times 4.184 \times -34=-8009\text{J}$

thus, there is not sufficient heat in the warm water to melt the ice completely

9.  $m_{\text{atom}}=58.9/6.023 \times 10^{23}=9.68 \times 10^{-23}$  g  $r=1.67 \times 10^{-8}$  cm

$d=0.1624 \times (9.68 \times 10^{-23} \text{ g} / (1.67 \times 10^{-8} \text{ cm})^3)=3.40 \text{ g/cm}^3$

10. Na<sub>2</sub>CO<sub>3</sub> gfw=106g  $19.3/106=0.182$  moles  $0.182/.150=1.21$  M

there are 2 Na<sup>+</sup> per mole so  $[\text{Na}^+]=2 \times 1.21=2.41$  M

12. A,B,C,E,I and J were correct

13.

Runs	$\Delta[\ ]$	$\Delta$ rate	Order
A 3 $\Rightarrow$ 4	*3	*3	1
B 4 $\Rightarrow$ 1	*2	NC	0
C 1 $\Rightarrow$ 2	*3	*9	2

$\text{rate}=k[\text{A}][\text{B}]^2$   $k=\text{rate}/[\text{A}][\text{B}]^2=7.9 \times 10^{-8}/(1.5 \times 0.05^2)=2.1 \times 10^{-5} \text{ M}^{-2} \text{ sec}^{-1}$

14. There are several possible approaches-it was not accepted if the student just wrote a single complex algorithm that had been memorized or programmed into a calculator. A common error was not differentiating between the Xs (X(liq) and X(vap))

$P_A$  and  $P_A^o \Rightarrow X_A(\text{liq})$   $X_A(\text{liq}) \Rightarrow X_B(\text{liq})$   $X_B(\text{liq}) \& P_B^o \Rightarrow P_B$   $P_B \& P_A \Rightarrow X_B(\text{vap})$

15.  $\Delta S=\Delta H/T=580\text{J}/340\text{K}=1.70\text{J/K}$