

Brooklyn College  
Chemistry Department  
Summer 2010, Lecture test 3.

Name \_\_\_\_\_

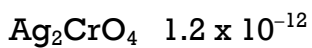
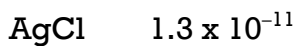
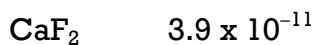
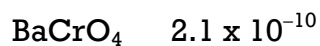
R = 8.31 joule/mol K.

**Assume that all reactions in this exam take place at 298.15K**  
**Thermodynamic Quantities. (At 298.15 K)**

Substance	$\Delta H^\circ_f$ (kJ/mol)	$\Delta G^\circ_f$ (kJ/mol)	$S^\circ$ (J/mol K)
$C_6H_6(l)$	49.0	124.5	172.8
$C_6H_6(g)$	82.9	129.7	269.2
$C_2H_4(g)$	52.30	68.11	219.4
$C_2H_5OH(l)$	-277.7	-174.76	160.7
$H_2(g)$	0	0	130.58
$NH_3(g)$	-46.19	-16.66	
$CO_2(g)$	-393.5	-394.4	213.6
$C_2H_6(g)$	-84.68	-32.89	229.5
$HCl(g)$		-95.27	
$H_2O(l)$	-285.85	-236.81	69.96

$$\Delta G = \Delta G^\circ + RT \ln Q$$

K<sub>sp</sub> values at 298 K.



Name \_\_\_\_\_

Short items must be answered on these pages in the spaces provided. (3 pts each)

\_\_\_\_\_ 1. The molar solubility of AgI is found to be  $9.1 \times 10^{-9}$  M. What is the  $K_{sp}$  of silver iodide?

\_\_\_\_\_ 2) Which of these salts has the greatest molar solubility?

A)  $\text{CaF}_2$  B)  $\text{BaCrO}_4$  C)  $\text{AgCl}$  D)  $\text{Ag}_2\text{CrO}_4$

\_\_\_\_\_ 3. Solid  $\text{CaF}_2$  is added to water until the solution becomes just saturated. What is the  $[\text{F}^-]$  in this saturated solution?

A)  $3.9 \times 10^{-11}$  M B)  $2.13 \times 10^{-4}$  M C)  $4.26 \times 10^{-4}$  M D)  $2.0 \times 10^{-11}$  M

\_\_\_\_\_ 4. The solubility of  $\text{Ag}_2\text{SO}_4$  in an aqueous solution would be **decreased** by the addition of A) nitric acid B) sulfuric acid  
C) sodium nitrate D) 12 molar ammonia solution

\_\_\_\_\_ 5. Find the molar solubility of  $\text{CaF}_2$  in a solution that is 0.200 molar in NaF.

\_\_\_\_\_ 6. Which is the correct formula for a precipitate formed in group I qualitative analysis? A)  $\text{BaSO}_4$  B)  $\text{Pb}(\text{NO}_3)_2$  C)  $\text{Hg}_2\text{Cl}_2$   
D)  $\text{CuS}$

7 to 9 - which has the highest standard molar entropy,  $S^\circ$ ?

\_\_\_\_\_ 7. A)  $\text{SO}_2(\text{g})$  B)  $\text{SO}_3(\text{g})$  C)  $\text{H}_2\text{O}(\text{g})$  (all at  $120^\circ\text{C}$  and 1 atm)

\_\_\_\_\_ 8. A)  $\text{N}_2(\text{g})$  at 1.0 atm and 298 K B)  $\text{N}_2(\text{g})$  at 0.50 atm and 350 K  
C)  $\text{N}_2(\text{g})$  at 0.50 atm and 298 K

\_\_\_\_\_ 9. A)  $\text{Br}_2(\text{l})$  B)  $\text{I}(\text{s})$  C)  $\text{Cl}_2(\text{g})$

In each of the following questions, (10 to 15) indicate by writing +, -, or 0 whether each of the quantities described is positive, negative or 0.

\_\_\_\_\_ 10.  $\Delta G^\circ$  for the melting of ice at  $25^\circ\text{C}$

\_\_\_\_\_ 11.  $\Delta H^\circ$  for the melting of ice at  $25^\circ\text{C}$

\_\_\_\_\_ 12.  $\Delta S^\circ$  for the formation of ammonia gas from nitrogen and hydrogen gas

\_\_\_\_\_ 13.  $\Delta G^\circ$  for the reaction  $\text{C}_2\text{H}_6(\text{g}) \rightarrow 2\text{C}(\text{s}) + 3\text{H}_2(\text{g})$

\_\_\_\_\_ 14.  $\Delta H^\circ$  for a reaction that is spontaneous at low temperatures, but NOT at high temperatures.

\_\_\_\_\_ 15.  $S^\circ$  of Na(s) at 298 K

16. Consider the reaction  $C(s) + O_2(g) \rightarrow CO_2(g)$  at 298 K.

\_\_\_\_\_ A. Find  $\Delta H^\circ$  for the reaction (actual value, not just +, - or 0 !)

\_\_\_\_\_ B. Find  $\Delta S^\circ$  for the reaction.

\_\_\_\_\_ C.  $\Delta G^\circ$  for this reaction would be **negative** at  
A) low temperatures only    B) high temperatures only  
C) all temperatures    D) no temperatures.

Problems: Must be answered in blue exam booklets.

I. How many **grams** of  $CaF_2$  are required to exactly saturate 100.0 mL of aqueous solution? (Show work step by step!) ( 8 pts)

II. Would a precipitate form when 1.00 mL of 0.0100 molar  $AgNO_3$  is added to 99.0 mL of  $2.0 \times 10^{-3}$  molar  $K_2CrO_4$  ? Show calculations that support your answer. No credit for a simple "Yes" or "No." ( 8 pts)

III. For the reaction  $C_2H_5OH(\ell) + 3 O_2(g) \rightarrow 2 CO_2(g) + 3 H_2O(\ell)$  at 298

A. Find  $\Delta H^\circ$ ,  $\Delta G^\circ$ , and  $\Delta S^\circ$  (9 pts)

B. Find  $S^\circ$ , the standard molar entropy, of  $O_2(g)$  (3 pts)

C. For the same reaction, forming **gaseous** water,  $\Delta G^\circ$  is  $-1299.75$  kJ.  
Find the value of  $\Delta G^\circ$  at 298 K for the vaporization of water,  
 $H_2O(\ell) \rightarrow H_2O(g)$  (3 pts)

IV. Find the equilibrium constant for the reaction  $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$  at 298 K. ( 4 pts)

B. Predict how this equilibrium constant will change if the temperature is increased. Explain your answer briefly. ( 3pts)

V. Use the information on the chart from page 1 to determine whether  $C_6H_6$  is a liquid or a gas at 298 K and 1.00 atmosphere. Justify your answer

(3)

VI. For the reaction at 298 K  $H_2(g) + Cl_2(g) \rightarrow 2 HCl(g)$

A. Determine the value of  $\Delta G^\circ$  (3)

B. Determine the value of  $\Delta G$  when the pressures of the three gases at 298 K are as follows:

$H_2 = 2.00 \times 10^{-3}$  atm,  $Cl_2 = 3.00 \times 10^{-3}$  atm, and  $HCl = 5.00$  atm. (6)

Extra Credit: Calculate the temperature above which the  $K_{eq}$  for the formation reaction of ammonia gas becomes **less than 1**. (You must assume that  $\Delta H^\circ$  and  $\Delta S^\circ$  remain constant despite changes in temperature.) (3 pts)

Extra Credit II (2 pts) What is the modern name for the substance that was originally called "dephlogisticated air"? Who discovered this substance?