CHEMISTRY 108 **Test #2** Name _____
SECTION 01 11:00 am - 11:50 am Thursday, March 12, 1998

Please read thoroughly and answer all questions. Points available are in parentheses.

(1.) Please consider the following balanced reaction, at 673 K:

$$CO\ (g) + H_2O\ (g) \quad HCOOH\ (g) \qquad K_p = 6.25 \times 10^{-11}$$

(a) Please calculate K_c (*5*)

(b) A vessel of volume 100.0 mL is charged with 0.280 g of CO and 0.180 g H_2O, sealed, and then brought to 673 K. Please show a concentration table (initial, change, and equilibrium concentrations), and then calculate the equilibrium concentration of HCOOH (*10*)

(c) Suppose you had also added in 10.00 g of helium (He) gas initially. Would this have made a difference to the equilibrium concentration of HCOOH (g)? (*5*)

(d) Suppose you had introduced a few grains of dry sand (which is pure silicon dioxide, SiO_2), because you wanted to see if it behaved as a catalyst. You found that it did not catalyze the reaction, and that it did not react in any way. Will this have any effect on the position of the equilibrium? (Please assume the sand is of negligible volume compared to the vessel) (*5*)

(e) Suppose now that the sand had been wet; which way will the equilibrium shift? Please answer one of (l ----> r), (r ----> l), or no shift (*5*)

(f) The wet sand is responsible for introducing 1.000 g H_2O. Please determine the new equilibrium concentration of HCOOH at 673 K (*5*)

(g) Using whatever is necessary from the data below, please indicate if the reaction to produce HCOOH is exothermic or endothermic at 673 K (*5*)

	ΔH_f^0 (kJ/mol)	S^0 (J/mol/K)	ΔG_f^0 (kJ/mol)
CO (g)	- 110	197.9	- 137.3
H_2O (g)	- 241.8	188.7	- 228.6
HCOOH (g)	- 363	251	+ 335

(h) Which direction will the equilibrium shift if the system is cooled to 598 K? Please answer one of (l ----> r), (r ----> l), or no shift (*5*)

(i) Now, you perform the same reaction as in (b), but you use a vessel of volume 155.0 mL. What effect will this have on the position of the equilibrium relative to that in (b)? Please answer one of (l ----> r), (r ----> l), or no shift (*5*)

(2.) Please calculate the pH of the solutions below. Please use **Table 1**, below, to determine the relevant K_a and K_b values. (*5* x *8*)

(a) A 0.050 M solution of formic acid
(b) A 0.050 M solution of sodium formate
(c) A buffer which is 0.100 M in formic acid and 1.000 M in sodium formate
(d) A 0.100 M solution of pyridinium nitrate
(e) A solution which is 0.100 M in pyridinium nitrate, 0.100 M in sodium nitrate, and 0.100 M in nitric acid

(3.) Please indicate whether the solutions below are acidic, basic, or neutral: (*5* x *2*)

(a) 55.6 M $NaClO_4$
(b) 1.00×10^{-7} M $HClO_4$
(c) 1.00 M $Al(ClO_4)_3$
(d) 1.00 M NH_4NO_2
(e) 1.00 M sodium phenoxide

Table 1:

Name of acid	Formula	K_a
Phenol	C_6H_5OH	1.3×10^{-10}
Nitrous Acid	HNO_2	7.1×10^{-4}
Formic Acid	HCOOH	1.8×10^{-4}

Name of Base	Formula	K_b
Pyridine	C_5H_5N	1.5×10^{-9}
Ammonia	NH_3	1.8×10^{-5}