Quiz 3

Name: ____

Remember:

- You can use notes on one side of one sheet of paper.
- A periodic table is provided.
- Turn in the note sheet with your exam.
- Significant figures will be included in points for each numerical problem.
- Point values for each question appear in parentheses in the margins

My signature below means that I agree to uphold the Honor Principle in taking this exam.

Signature: ____

Please wait to start your quiz until everyone is seated and the instructor tells you to begin. There are useful tables and equations on the first page of the exam.

Good Luck!

1. For the reaction

$$2\ NOCl\ (g)\ \text{£}\ 2\ NO\ (g) + Cl_2\ (g)$$

The value of K_c at 350º C is 4.3×10^{-3} M.

If 0.010 moles of each species were placed in a 2.00 L reaction flask at 350º C, which statement below would be true? Circle ALL correct responses and support your answers with a calculation. (A clear calculations must be shown for full credit!)

(2) The reaction is at equilibrium. The reaction will produce more products The reaction will produce more reactants

(5)

(5) Calculate K_p for the reaction at this temperature.

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2. Consider a 0.050 M solution of formic acid, HCOOH

(4) Write the acid dissociation reaction and the equilibrium expression for the reaction.

(2) Label the acid dissociation reaction with the acid and conjugate base.

(2) Compare the relative strengths of the acid and conjugate base. Circle one:

Strength of acid > strength of conjugate base

Strength of acid < strength of conjugate base

Strength of acid = strength of conjugate base

(5) Calculate the pH of the solution.

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2. Continued: (0.050 M solution of formic acid, HCOOH)
100.0 mL of the above solution is titrated to the equivalence point with 50.00 mL of 0.100 M NaOH. Circle the pH that you expect the solution to have after titration to the equivalence point:

(2) acidic neutral basic

(5) Calculate the pH of the solution after titration to the equivalence point. Remember that titration changes the total volume of the solution.

Calculate the concentration of the following species in solution, after titration to the equivalence point. Use your work from above to help you.

(1) $[HCOO^-]$ =

(1) $[HCOOH]$ =

(1) $[H_3O^+]$ =

(1) $[OH^-]$ =

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3. Circle the correct responses for each question. There may be MORE THAN ONE correct answer. You will receive a point for each letter that is correctly circled and for each that is correctly left uncircled. It is not in your best interest to guess blindly!

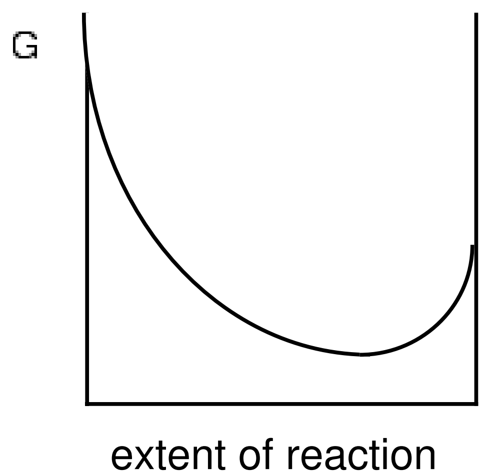
(4) For a reaction with a ΔG^o less than zero

A. The formation of products is spontaneous.
B. The reaction goes to completion.
C. The equilibrium constant is greater than 1.
D. The reaction is exothermic.

(4) For the reaction $CH_3COO^- + H_3O^+$ £ $CH_3COOH + H_2O$
the equilibrium constant Kc is

A. K_a of acetic acid
B. K_b of acetate ion
C. $1/K_a$ of acetic acid
D. K_w/K_a of acetic acid

(4) For the reaction shown in the follow graph of Gibbs free energy vs. extent of reaction, which statements are true?



A. At equilibrium, products are favored over reactants.
B. ΔG^o for the reaction is negative.
C. If pure products are placed in a reaction vessel, reactants will spontaneously form.
D. K is greater than 1.

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3. Multiple Choice, continued.

(4) If a weak acid solution is titrated to the equivalence point with strong base, the solution that results is

A. A buffer solution
B. A solution of the conjugate base of the weak acid.
C. A solution of the conjugate acid of the strong base.
D. At neutral pH.

(4) Consider a 100 mL sample of 0.5 M H_2SO_4 solution. Which of the following statements is true of this solution?

A. pH is less than 0
B. 100 mL of 0.5 M NaOH would be required to neutralize the solution.
C. The first pK_a is less than 0
D. The concentration of undissociated H_2SO_4 can be considered negligible.

(4) Which of the following salts is acidic in aqueous solution?

A. $NaCH_3COO$
B. NH_4Cl
C. KCl
D. $Ba(OH)_2$

(4) NH_3 (aq) is titrated with strong acid. Which of the following statements are true about the equivalence point?

A. The moles of acid added equals the total moles of base in the original sample.
B. The solution at the equivalence point will be neutral.
C. The pH will be higher at the equivalence point then it was at the start of the titration.
D. The pH will rise sharply at the equivalence point.

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4. Choose FOUR of the solutions below and calculate the pH
(5 each)

0.130 M KOH

0.243 M sodium benzoate

0.100 M pyridine

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4. Continued (CHOOSE FOUR, 5 points each)

0.45 M Ammonium Chloride

0.5 M acetic acid AND 0.5 M sodium acetate

0.163 M benzoic acid

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5. A sample of 2.00 g of gaseous ammonia is placed in a 25.0 mL container and heated to 300.0º C. After equilibrium was reached, the concentration of hydrogen gas was 1.58 M. What is the value of K_c for the following reaction at 300.0º C?

$$2\ NH_3\ (g)\ \ £\ \ N_2\ (g)\ +\ 3\ H_2\ (g)$$

(6)

What would happen if each of the following changes were made to the system AT EQUILIBRIUM? Circle the correct response.

(1) Increase volume: No change more products form more reactants form

(1) Remove H_2 (g) : No change more products form more reactants form

(1) Add NH_3 (g): No change more products form more reactants form

(3) Increase temperature: No change more products form more reactants form

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Useful Equations and Constants

$R = 8.31451\ J\ mol^{-1}\ K^{-1}$
$\quad = 0.082058\ L\ atm\ mol^{-1}\ K^{-1}$

$N_a = 6.0221 \times 10^{23}$

$Pa = 1\ kg\ m^{-1}\ s^{-2}$

$1\ atm = 1.01325 \times 10^5\ Pa$

$1\ atm = 760\ torr$

$T\ (K) = T\ (°C) + 273.15$

$PV = nRT$

$pH = pK_a - \log [HA]/ [A^-]$

$\Delta G = \Delta H - T\ \Delta S$

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

$\Delta G^\circ = -RT \ln K$

$K_c = K_p\ (RT)^{-\Delta n}$

$pH = -\log [H_3O^+]$

$pK_a = -\log K_a$

$K_w = 10^{-14} = [OH^-][H_3O^+]$

Thermodyanamic Data

	$\Delta H^o\ f$	$\Delta G^o\ f$
NH_3 (g)	–46.11 kJ/mol	–16.48 kJ/mol
N_2 (g)	0	0
H_2 (g)	0	0

Acid Dissociation Constants

Acid	**HA**	**A^-**	**Ka**	**pKa**
Sulfuric (1)	H_2SO_4	HSO_4^-	$\sim 10^2$	~ –2
Formic	HCOOH	$HCOO^-$	1.77×10^{-4}	3.75
Benzoic	C_6H_6COOH	$C_6H_6COO^-$	6.46×10^{-5}	4.19
Acetic	CH_3COOH	CH_3COO^-	1.76×10^{-5}	4.75
Pyridinium ion	$C_5H_5NH^+$	C_5H_5N	5.6×10^{-6}	5.25
Ammonium ion	NH_4^+	NH_3	5.6×10^{-10}	9.25

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