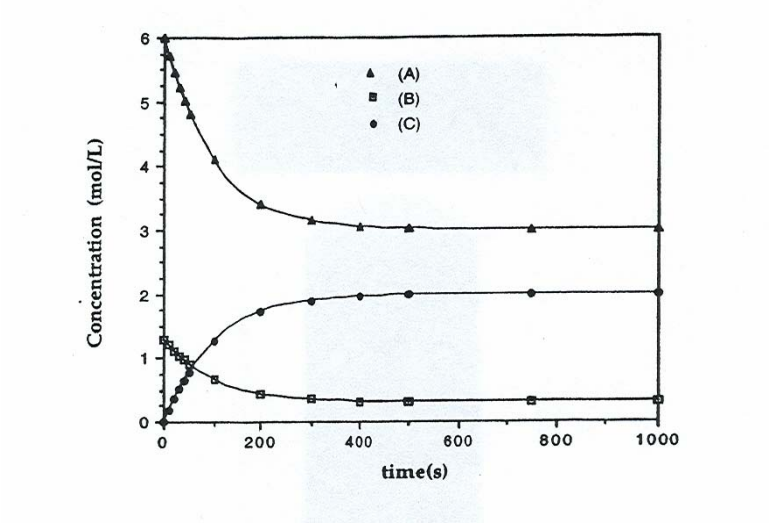
INTRODUCTORY CHEMISTRY
TEST 1, FALL 2005

Name _____

Multiple Choice: Circle the best answer to each question. There is only one correct answer to each question.

1. What is the balanced chemical equation described by the graph. Note that the initial concentrations of reactants are different.



a) A + B → C b) 6A + B → 2C c) 3A + 2B → C
d) 6A + 2B → C e) 3A + B → 2C

2. At equilibrium the concentrations of NO and O_2 are 1.0 x 10^{-3} and 5.0 x 10^{-2} M, respectively. The K_c for the reaction at a certain temperature is found to be 47.6. What is the concentration of NO_2 at equilibrium?

$$2\ NO(g) + O_2(g) \leftrightarrow 2NO_2(g)$$

a) 2.4 x 10^{-3} M b) 2.4 x 10^{-6} M c) 1.5 x 10^{-3} M
d) 4.9 x 10^{-2} M e) 4.7 x 10^{-3} M

3. What is the conjugate base of HCO_3^-?
a) CO_3^- b) H_2CO_3 c) $H_2CO_3^-$ d) $H_2CO_3^+$ e) CO_3^{2-}

4. Determine the pH of a 0.015 M solution of KOH.
a) 1.8 b) 12.2 c) 8.7 d) 10.5 e) none of these

5. Rank the following 0.010M aqueous solutions in order of increasing pH.

$KClO_4$, $HClO_4$, $HClO_2$, $LiClO_2$

a) $KClO_4 < HClO_4 < HClO_2 < LiClO_2$
b) $HClO_4 < HClO_2 < KClO_4 < LiClO_2$
c) $HClO_4 < HClO_2 < LiClO_2 < KClO_4$
d) $LiClO_2 < KClO_4 < HClO_4 < HClO_2$
e) none of these

6. The following reaction is at equilibrium. The concentration of the F_2 is then *decreased* by the addition of a complexing reagent that reacts with F_2. Which of the following will be true as the reaction shifts to once again establish equilibrium?

$$Cl_2(g) + 3\ F_2(g) \leftrightarrow 2ClF_3(g)$$

a) The concentrations of Cl_2, F_2 and ClF_3 in the final equilibrium must all equal the concentrations in the initial equilibrium.
b) ClF_3 in the initial equilibrium > ClF_3 in the final equilibrium
c) Cl_2 in the initial equilibrium > Cl_2 in the final equilibrium
d) F_2 in the initial equilibrium = F_2 in the final equilibrium
e) none of these

7. The concentration of F_2 decreases by 0.020 M as the reaction below occurs. What will be the change in the concentration of ClF_3?

$$Cl_2(g) + 3\ F_2(g) \leftrightarrow 2ClF_3(g)$$

a) 0.020M b) 0.010 M c) 0.060 M d) 0.030 M
e) none of these

8. Which of the following is true for the chemical equation:

$$(CH_3)_2NH_2^+(aq) + C_5H_5N(aq) \leftrightarrow (CH_3)_2NH(aq) + C_5H_5NH^+(aq)$$

a) $(CH_3)_2NH_2^+$ and $(CH_3)_2NH$ are acids
b) C_5H_5N and $C_5H_5NH^+$ are acids
c) $(CH_3)_2NH_2^+$ and $C_5H_5NH^+$ are acids
d) $(CH_3)_2NH_2^+$ and $(CH_3)_2NH$ are bases
e) C_5H_5N and $C_5H_5NH^+$ are bases

9. Use the relationship between structure and acid strength to determine which of the following is true.
a) H_2S is a stronger acid than H_2Se
b) PH_3 is a stronger acid than H_2S
c) $HONO_2$ is a stronger acid than HONO
d) HSO_3^- is a stronger acid than H_2SO_3
e) none of these

10. A buffer is prepared by mixing equal concentrations of HF and NaF. Which of the following will occur as the strong acid is added to the buffer?
a) The F^- concentration will decrease and the HF concentration will increase.
b) The F^- and HF concentrations will decrease.
c) The F^- and HF concentrations will increase.
d) The F^- concentration will increase and the HF concentration will decrease.
e) none of these

Problems: Show all work in a neat orderly step-by-step fashion. Include all units and maintain significant figures. Discussion: Use correct grammar and complete sentences.

1. The equilibrium state for chemical reactions is referred to as a "dynamic equilibrium". Explain what this means.

2. Write the equilibrium constant expression for the reaction (assume all products and reactants to be gases).

	2A	+ B	↔	3C	+ D
Initial	0.10M	0.10M		0.10M	0.10M

At equilibrium the concentration of D is determined to be 0.12M. Determine the equilibrium concentrations of A, B, and C.

[A] = ____ [B] = _____ [C] = _____

Determine the equilibrium constant, K_c.

K_c= _____

3. Li_2CO_3 is a slightly soluble salt. Only 0.0742 moles of Li_2CO_3 will dissolve in a liter of water to form a saturated solution. Write the chemical equation for the dissolution of solid Li_2CO_3.

Write the equilibrium expression, K_{sp}, that describes this equilibrium.

Determine the value of K_{sp}.

K_{sp} = _____

4. The salt ammonium iodide, NH_4I, is dissolved in water to produce a 0.025 M solution. Show the chemical reaction for the ionization of the salt.

   Show the chemical reaction for one of the salt's ions behaving as an acid in solution.

   Determine the equilibrium concentrations of I^-, NH_4^+, OH^-, NH_3 and H_3O^+ given that the K_a of NH_4^+ is 1.8×10^{-5}.

   $[I^-]$ =_____ $[NH_4^+]$ =_____ $[OH^-]$ =_____ $[NH_3]$ =_____ $[H_3O^+]$ = _____

5. Classify the following as acids, bases, or salts. Show chemical equations that describe what happens when each is placed in water. More than one equation may be necessary to describe the chemistry for an individual substance. Indicate whether the resulting solution is acidic, basic or neutral.

   Classify *Equations* *Solution pH*

   a) HCN

   b) KNO_2

   c) LiI

   d) $Sr(OH)_2$

6. The pH of a 0.10M solution of Na_2CO_3 is 11.6. What are the $[H_3O]^+$ and $[OH^-]$?

Answer Key

1. e	6. b
2. c	7. e
3. e	8. c
4. b	9. c
5. b	10. a

Problems:

1. The overall reaction has stopped. However, individual reactant molecules are still reacting to produce product and product molecules are reacting to produce reactant at the same rate.

2. $K_c = C^3D/A^2B$
   [A] = 0.06 M [B] = 0.08 M [C] = 0.16 M K_c = 1.7

3. $Li_2CO_3(s) \leftrightarrow 2\ Li^+(aq) + CO_3^{2-}(aq)$
   $K_{sp} = [Li^+]^2[CO_3^{2-}]$
   $K_{sp} = 1.6 \times 10^{-3}$

4. $NH_4I(s) \rightarrow NH_4^+(aq) + I^-(aq)$
   $NH_4^+(aq) + H_2O \leftrightarrow NH_3(aq) + H_3O^+(aq)$
   $[I^-] = 0.025$ M $[NH_4^+] = 0.024$ M $[OH^-] = 1.5 \times 10^{-11}$M
   $[NH_3] = 6.7 \times 10^{-4}$M $[H_3O^+] = 6.7 \times 10^{-4}$M

5.

Classify	*Equations*	*Solution pH*
acid	$HCN + H_2O \leftrightarrow H_3O^+ + CN^-$	acidic
salt	$KNO_2(s) \rightarrow K^+(aq) + NO_2^-(aq)$ $NO_2^-(aq) + H_2O \leftrightarrow HNO_2(aq) + OH^-(aq)$	basic
salt	$LiI(s) \rightarrow Li^+(aq) + I^-(aq)$	neutral
base	$Sr(OH)_2 \rightarrow Sr^{2+}(aq) + 2\ OH^-(aq)$	basic

6. $[H_3O^+] = 2.5 \times 10^{-12}$M $[OH^-] = 4.3 \times 10^{-3}$M