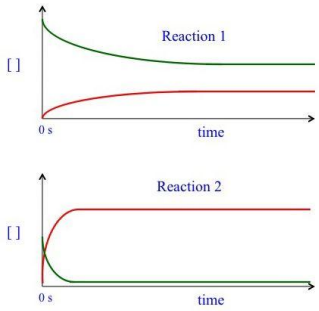
Name _____ U#_____ Section 0901

CHM 2046 EXAM 2 Fall 2013 Form A

Fill in your name, U#, and section on this test booklet. Fill in and bubble in your name, U#, and section (0901) on the scantron form. This is FORM A. Mark the best answer after reading all possible choices. Use a #2 pencil and make clean erasures to insure proper scoring. When finished, turn in your scantron sheet and your short answer responses to the proctor. Please show your ID to the proctor. Good Luck!

1. Compare the two plots for progress of reaction and choose the correct statement (scales are the same for both plots).



A. Only Reaction 2 reaches equilibrium.
B. Reaction 1 favors the products.
C. Ke for Reaction 1 > Ke for Reaction 2.
D. Reaction 1 reaches equilibrium faster than Reaction 2.
E. Reaction 2 favors the products.

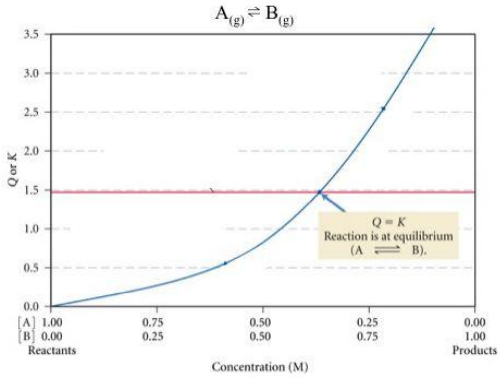
2. Consider the reaction:

$$NH_4HS_{(s)} \rightleftharpoons NH_{3(g)} + H_2S_{(g)}$$

At a certain temperature, Kc = 8.5×10^{-3}. A reaction mixture at this temperature containing solid NH_4HS has $[NH_3] = 0.166$ M and $[H_2S] = 0.166$ M. Choose the correct option:

A. Reaction proceeds to the right forming the gases.
B. Reaction proceeds to the left forming more solid.
C. The reaction is at equilibrium already; therefore, there is no change in the concentrations.
D. $[NH_3]$ will increase and $[H_2S]$ will decrease

3. Consider the reaction and plot below:



If the initial concentrations are: [A] = 0.60 M and [B] = 0.40 M.

A. Equilibrium will shift until [A] = [B] = 0.50 M.
B. Equilibrium will shift to increase [B] and decrease [A].
C. Equilibrium will shift to increase [A] and decrease [B].
D. Concentrations will not change.
E. At equilibrium [A] = [B].

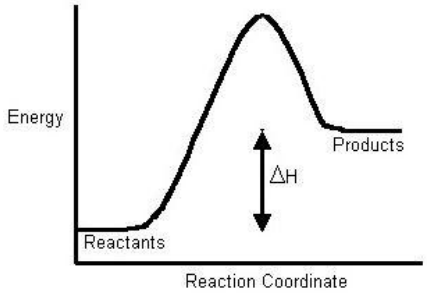
4. Consider the reaction and table below:

	$CO_{(g)}$ +	$2\ H_{2(g)}$ ⇌	$CH_3OH_{(g)}$
Initial	0.50 M	0.20 M	0.10 M
Change	$-x$		
Equil.			

Which option is the correct expression for the concentration of H_2 at equilibrium?

A. $[H_2] = 0.20 - 2x$
B. $[H_2] = 2\ (0.20 - x)$
C. $[H_2] = 0.20 - x^2$
D. $[H_2] = 0.20 + 2x$
E. $[H_2] = (0.20 - 2x)^2$

5. When heat is added to the chemical reaction represented by the energy profile below:



A. The equilibrium remains unchanged
B. The equilibrium constant remains unchanged
C. The equilibrium shifts towards the products
D. The equilibrium shifts towards the reactants

6. The following reaction occurs in the gas phase. After equilibrium is established, the volume is expanded to twice its original value. What effect will this disturbance have on the position of the equilibrium?

$$CO_{(g)} + 2\,H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

A. The equilibrium remains unchanged
B. The concentration of all reactants and products will increase.
C. The equilibrium shifts towards the products
D. The equilibrium shifts towards the reactants

7. Consider the reaction at equilibrium:

$$2\,BrNO_{(g)} \rightleftharpoons 2\,NO_{(g)} + Br_{2(g)}$$

Predict the effect on the position of the equilibrium when some of the Br_2 is removed from the mixture.

A. The equilibrium remains unchanged
B. The equilibrium shifts towards the reactants
C. The equilibrium shifts towards the products
D. The concentration of all reactants and products will increase.

8. Consider the chemical equations and Ke values. Choose the correct option.

(I) $CO_{(g)} + 2\,H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$ $\quad K_e = 2.17 \times 10^4$

(II) $2\,COF_{2\,(g)} \rightleftharpoons CO_{4(g)} + CF_{4(g)}$ $\quad K_e = 2.38 \times 10^6$

Reaction (II):
A. Is faster than Reaction (I).
B. Releases more energy than Reaction (I).
C. Favors more the products than Reaction (I).
D. Shifts towards the reactants when volume is compressed.

9. What is the $[H^+]$ concentration of a 0.100 M solution of acetylsalicylic acid, $HC_9H_7O_4$? ($K_a = 3.3 \times 10^{-4}$)

A. 4.68×10^{-3}
B. 6.80×10^{-4}
C. 1.00×10^{-1}
D. 5.74×10^{-3}
E. 1.8×10^{-3}

10. Calculate the pH of a solution at 25°C in which the $[OH^-] = 5.4 \times 10^{-7}$M.

A. 4.51
B. 7.05
C. 7.73
D. 6.38
E. 8.40

11. Which of the following is a conjugate acid-base?

A. H_3O^+ / OH^-
B. H_2CO_3 / H_3O^+
C. H_2CO_3 / HCO_3^-
D. $HClO_2 / HClO$
E. H_2CO_3 / CO_3^{2-}

12. Bronsted & Lowry defined a base as a proton acceptor and an acid as a proton donor. Consider the reaction below and choose the **INCORRECT** option:

$H_2NCH_2CH_3(aq) + H_2O(l) \rightleftharpoons [H_3NCH_2CH_3]^+(aq) + HO^-(aq)$

A. $H_2NCH_2CH_3$ is a base
B. $[H_3NCH_2CH_3]^+$ is an acid
C. In this reaction, H_2O is acting as a base
D. HO^- is a base

13. Choose the correct option. A solution of a strong acid:

A. Always has pH < 1.00
B. Is a very concentrated solution of an acid such as HNO_2
C. Contains an acid with Ka > 1.0 x10^{-2}.
D. Contains an acid that is completely ionized.
E. Is a solution of a polyprotic acid.

14. Consider an aqueous mixture of 0.10 M of Chlorous acid, $HClO_2$ ($K_a = 1.0 \times 10^{-2}$) and 0.10 M of Hydrocyanic acid, HCN ($K_a = 4.9 \times 10^{-10}$) at 25°C.

A. Kw (autoionization of H_2O) is < 1.0x10^{-14}.
B. The ionization of chlorous acid, $HClO_2$ is suppressed.
C. The pH can determined using only the concentration of chlorous acid, $HClO_2$.
D. Chlorous acid, $HClO_2$ is a strong acid.

15. The K_a of hypochlorous acid, HClO, is 3.0×10^{-8} at 25°C. Calculate the pH of a 0.030 M hypochlorous acid solution.

A. 4.52
B. 8.94
C. 4.79
D. 1.41
E. 5.82

16. K_w of pure water at **25**°C is 1.0 x10^{-14} and $[H^+] = [OH^-] = 1.0 \times 10^{-7}$ mol/L.

$$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

K_w of pure water at **0**°C is 1.15 x 10^{-15}.
Choose the correct answer:

A. For pure water at **0**°C, [H+] > [OH-]
B. The pH of pure water at **0**°C is 7.47
C. The pH of pure water at **0**°C is 7.00
D. For pure water at **0**°C, [H+] < [OH-]
E. Pure water at **0**°C is not amphoteric.

17. Hydrobromic acid, HBr, is a strong acid. The K_a of hypochlorous acid, HClO, is 3.0×10^{-8} at 25°C.

$HBr_{(aq)} \rightarrow H^+_{(aq)} + Br^-_{(aq)}$

$HClO_{(aq)} \rightleftharpoons H^+_{(aq)} + ClO^-_{(aq)}$

You have one solution of HBr that is 0.15 M and a separate solution of HClO that is also 0.15 M.

A. Both solutions have the same pH.
B. The HBr solution has a higher pH.
C. The HClO solution is neutral since the Ka is small.
D. $[OH^-]$ for the HClO solution is greater than $[OH^-]$ for the HBr solution.
E. The pH of the HBr solution cannot be estimated without the Ka value.

18. Bond polarity and bond strength are two structural factors that affect acid strength. Which of the following oxyacids has the greatest Ka? (If necessary, see Periodic Table under Useful Information.)

A. H-O-I
B. H-O-Br
C. H-O-Cl
D. Options A, B and C are strong acids.

19. Which of the following weak acids would have the **strongest** conjugate base?

A. Hypoiodous acid, HIO ($K_a = 2.3 \times 10^{-11}$)
B. Lactic acid, $CH_3CH(OH)COOH$ ($K_a = 8.4 \times 10^{-4}$)
C. Chlorous acid, $HClO_2$ ($K_a = 1.0 \times 10^{-2}$)
D. Hydrocyanic acid, HCN ($K_a = 4.9 \times 10^{-10}$)

20. Which of the following ionic compounds forms an **acidic** solution when dissolved in water?

A. $NaClO_4$
B. NH_4I
C. LiCl
D. CH_3CO_2Na
E. Na_3PO_4

21. A 0.1 M solution of which of the following weak acids would have the **highest** pH?

A. Nitrous acid, HNO_2 $K_a = 4.6 \times 10^{-4}$
B. Iodic acid, HIO_3 $K_a = 1.7 \times 10^{-1}$
C. Hydrocyanic acid, HCN $K_a = 4.9 \times 10^{-10}$
D. Hydrosulfuric acid, H_2S $K_a = 8.9 \times 10^{-8}$

22. A 0.300 M solution of an unknown substance has a **pOH** of 3.20. Choose the correct option:

A. the unknown substance is acidic
B. the solution is basic
C. the unknown is a strong base
D. the pH is 13.5
E. the unknown is a strong acid

23. What is the **pH** of a 0.025 M solution of **LiOH**?

A. 11.82
B. 1.80
C. 7.00
D. 9.54
E. 12.40

24. Determine the pH of a solution of dimethylamine $(CH_3)_2NH$ that is 0.1 mol/L. $\mathbf{K_b = 6.9 \times 10^{-4}}$

A. 11.9
B. 5.8
C. 10.0
D. 7.3
E. 8.5

25. A student measured out **20.00 mL** of a 0.250 M solution of a strong base (NaOH). Subsequently, the student diluted this sample to **200.00 mL**. Compared to the **pH** of the initial solution, the **pH** of the final solution is:

A) The same
B) Higher
C) Lower
D) The pH of the final solution is neutral
E) There is not enough information to answer

Pick only one of the following two questions. Please be concise but thorough in responding. Turn in this sheet with your scantron.

Name: _____ U#: _____

(A) Maintaining the proper pH in swimming pools is very important. When it is too acidic, corrosion of metal equipment and etching on the surface of materials may occur. When it is too basic, scaling on the pool surface, and plumbing equipment, and cloudiness may happen. Additionally, the pH may affect the effectiveness of the chlorine added to keep a pathogen-free environment!
Your little cousin (9^{th} grader) is intrigued by this talk about pH and acids and bases. Help her by explaining your understanding of acids and bases and the pH scale. You may use chemical concepts and equations and mathematical equations and examples in your explanation. Be concise but clear and thorough.

(B) Given a mixture of a strong acid (e.g. HNO_3) and a weak acid (e.g. HF) we say that the contribution of the weak acid to the pH of the solution is negligible. Explain the reasons behind this. You may use chemical and mathematical equations in your explanation. Be concise but clear and thorough.

Useful information:

Hypothetical reaction:

$$aA + bB \rightleftharpoons cC + dD$$

Expression of equilibrium constant:

$$K_e = [C]_e^c[D]_e^d/[A]_e^a[B]_e^b$$

Expression of concentration quotient, Q:

$$Q = [C]^c[D]^d/[A]^a[B]^b$$

Ionization of a weak acid:

$$HA_{(aq)} \rightleftharpoons A^-_{(aq)} + H^+_{(aq)}$$

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons A^-_{(aq)} + H_3O^+_{(aq)}$$

Acid Ionization Constant for a weak acid, HA:

$$Ka = [H^+]\,[A^-]/[HA]$$

$$Ka = [H_3O^+]\,[A^-]/[HA]$$

Aqueous equilibrium for a weak base:

$$A^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HA^-_{(aq)} + HO^-_{(aq)}$$

Expression of equilibrium Constant for a weak base, A^-:

$$Kb = [HA]\,[OH^-]/[A^-]$$

Auto-ionization of water:

$$H_2O_{(l)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HO^-_{(aq)}$$

Ion Product Constant for water, Kw:

$$Kw = [H_3O^+]\,[OH^-] \text{ (at } 25°C, Kw = 1.0 \times 10^{-14})$$

Relationship between Ka, Kb and Kw:

$$Ka \times Kb = Kw$$

Relationship between pH, pOH and pKw:

$$pKw = pH + pOH$$

Expression for the pH scale:

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

Expression for the p-function of *x*:

$$px = -\log x$$