CHEMISTRY 102   FALL 2010
EXAM 3   FORM B   SECTION 501   DR. KEENEY-KENNICUTT

Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, **put the same answer down for both questions** for 5 pts. If you cannot decide between two answers, put your best answer down for the first (odd) question and the other answer down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the second one correct you'll get 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put everything in the envelope and wait to be excused. At the table, take everything out of the envelope. You can pick up the multiple choice part with the answers outside my office after 3pm.
(6) There are a total of 36 questions (20 actual questions).

PART 1

1&2. The conjugate base of HCO_3^- is:

(a) H_2CO_3 (b) OH^- (c) H_2O (d) CO_3^{2-} (e) none of these

3&4. The compound, HBrO is a:_____ .

(a) weak acid   (b) strong acid   (c) weak base   (d) strong base   (e) neutral

5&6. Which equilibrium has the thermodynamic equilibrium constant expression: $K_{thermo} = (p_x)/[Y]^3$

(a) $Y(aq) \rightleftarrows 3X(g)$ (b) $3Y(s) \rightleftarrows X(g)$

(c) $3Y(aq) \rightleftarrows 3Z(s) + X(g)$ (d) $X(g) \rightleftarrows Z(\ell) + 3Y(aq)$

(e) $X(g) \rightleftarrows 3Y(g) + 3Z(s)$

7&8. Consider the titrations of the pairs of aqueous acids and bases listed at the left. For which pair is the pH at the equivalence point stated INCORRECTLY?

Acid-Base Pair	pH at Equivalence Point
(a) $HClO_3$ + KOH	equal to 7
(b) HBr + NH_3	less than 7
(c) CH_3COOH + NaOH	more than 7
(d) HNO_3 + $Ba(OH)_2$	equal to 7

© Keeney-Kennicutt, 2010   **B1**

(e) HF + NaOH   less than 7

9&10. The hydrolysis constant used when finding the pH of a solution of NaCN is:

(a) $\dfrac{K_w}{K_a \text{ for } Na^+}$

(b) $\dfrac{K_a \text{ for } Na^+}{K_w}$

(c) $\dfrac{K_a \text{ for HCN}}{K_w}$

(d) $\dfrac{K_w}{K_a \text{ for HCN}}$

(e) $\dfrac{K_a \text{ for HCN}}{K_b \text{ for } CN^-}$

11&12. Which will be a buffer when equal volumes of the following solutions are mixed?

(a) 0.1 M HCN and 0.2 M NaCN

(b) 0.1 M $HClO_3$ and 0.2 M $NaClO_3$

(c) 0.1 M NH_3 and 0.1 M NaCl

(d) 0.1 M CH_3NH_2 and 0.2 M NH_4Cl

(e) 0.1 M NaOH and 0.1 M NaF

13&14. Consider 0.1 M solutions of the following weak acids:

HClO $K_a = 3.5 \times 10^{-8}$
HNO_2 $K_a = 4.5 \times 10^{-4}$

Which of the following statements is NOT correct?

(a) Nitrous acid is a stronger acid than hypochlorous acid.

(b) $[ClO^-]$ in HClO solution > $[NO_2^-]$ in HNO_2 solution.

(c) The concentration of OH^- ions is greater in the HClO solution.

(d) The pH of the HNO_2 solution is lower than the pH of the HClO solution.

(e) $[H^+]$ in HNO_2 solution > $[H^+]$ in HClO solution.

15&16. In a sample of pure water, only one of the following statements is ALWAYS true at all conditions of temperature and pressure. Which one is ALWAYS true?

(a) $[H_3O^+] \times [OH^-] = 1.0 \times 10^{-14}$

(b) pH = 7.0

(c) $[H_3O^+] = [OH^-]$

(d) pOH + pH = 14.0

(e) $[H_3O^+] = 1.0 \times 10^{-7}$ M

17&18. Calculate the thermodynamic equilibrium constant at 25°C for a reaction for which $\Delta G° = +23.0$ kJ per mol rxn?

(a) 9.14   (b) 9.3×10^{-5} (c) 1.0×10^4 (d) 4.8×10^{-10} (e) 0.0034

19&20. What is the pH of a 4.00×10^{-2} M NaOH(aq) solution?

(a) 12.60   (b) 10.76   (c) 11.22   (d) 13.00   (e) 12.41

21&22. What is the percent ionization of a 0.40 M solution of $(CH_3)_3N$?

(a) 3.0%   (b) 0.73%   (c) 2.2%   (d) 1.7%   (e) 1.4%

23&24. Calculate the pH of the solution resulting from the addition of 30.0 mL of 0.300 M HBr to 70.0 mL of 0.100 M NaOH.

    (a) 7.00   (b) 2.61   (c) 1.70   (d) 2.30   (e) 12.85

25&26. What is the pH of a 0.20 M NH_4Cl solution?

    (a) 7.00   (b) 4.17   (c) 9.91   (d) 9.12   (e) 4.98

27&28. Calculate the pH that results when 30.0 mL of 1.00 M NaOH is added to 500.0 mL of a solution composed of 0.200 M dimethylamine and 0.100 M dimethylammonium chloride.

(a) 10.98   (b) 10.84   (c) 10.01   (d) 11.68   (e) 2.35

The following 5 questions (29 – 35) deal with a single titration:

29&30. A 40.0 mL sample of 0.300 M formic acid is titrated with 0.200 M NaOH. Calculate the initial pH before the titration is begun.

(a) 1.93   (b) 2.13   (c) 2.41   (d) 2.85   (e) 0.55

OVER ⇒

B5

31&32. A 40.0 mL sample of 0.300 M formic acid is titrated with 0.200 M NaOH. Calculate the pH after 25.0 mL of 0.200 M NaOH has been added.

(a) 3.11   (b) 3.25   (c) 3.60   (d) 3.91   (e) 3.47

PART 2

**Please read and sign: "On my honor, as an Aggie, I have neither given
nor received unauthorized aid on this exam."**   _____

(5 pts) **33.** A 40.0 mL sample of 0.300 M formic acid is titrated with 0.200 M NaOH. Calculate the pH at the equivalence point.

(5 pts) **34.** A 40.0 mL sample of 0.300 M formic acid is titrated with 0.200 M NaOH. Calculate the pH after 70.0 mL of 0.200 M NaOH is added.

OVER $\Rightarrow$

(5 pts) **35.** A 40.0 mL sample of 0.300 M formic acid is titrated with 0.200 M NaOH. Using the answers to Questions 29-34, sketch the titration curve with pH on the vertical axis and milliliters of base added on the horizontal axis. Label the axes and plot your 4 points. Point out the buffer region and the equivalence point. If you cannot complete the calculations, sketch what the curve should look like for partial credit.
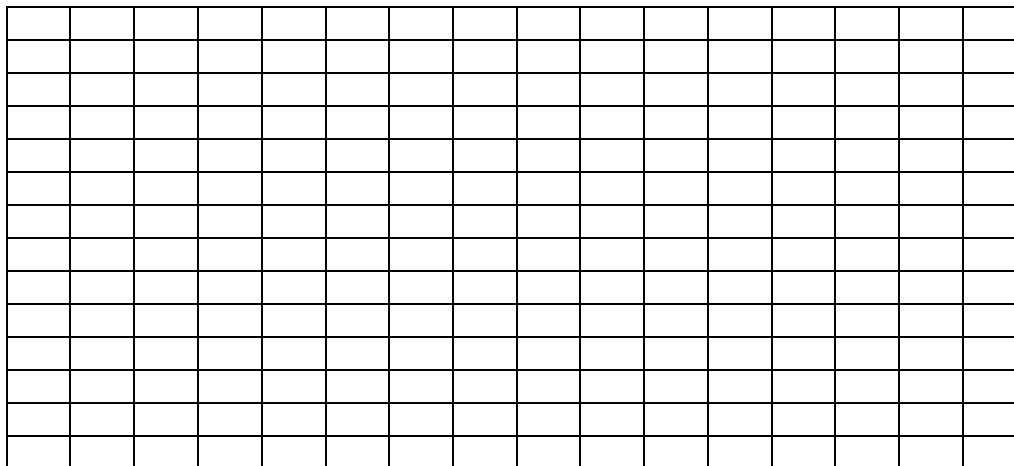
36. A weak acid indicator, HIn (K_a = 1.0 x 10^{-3}) ionizes as follows:
$$HIn \rightleftharpoons H^+ + In^-$$
clear   red
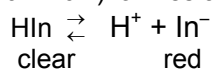
(2 pts) (a) The endpoint of an acid-base titration that uses this indicator will be at pH = _____.

(2 pts) (b) Explain your answer to (a) using the equilibrium expression.

(1 pt) (c) The color at pH = 5 will be _____.

SCRAP PAPER OR COMMENTS ON EXAM