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 33 questions (19 actual questions).

PART 1

1&2. A 0.10 M solution of which one of the following salts has a pH greater than 7?

(a) KBr  (b) CH₃NH₃Cl  (c) Ba(NO₃)₂  (d) KClO  (e) NH₄Cl

3&4. Which one of the following acids is NOT a strong acid?

(a) HNO₃  (b) HClO₃  (c) HClO₄  (d) HCl  (e) HF

5&6. The conjugate acid of HF is:

(a) H₂F⁺  (b) OH⁻  (c) F⁻  (d) H₃O⁺  (e) none of these

7&8. The acid-base indicator, Hln, has a Kₐ value of 1.0 x 10⁻⁸. The endpoint for any titration using this indicator will occur at pH = ____:

(a) 7  (b) 10  (c) 6  (d) 8  (e) 13
9&10. Which of the following combinations are buffer solutions? All components are present in 0.50 M concentrations.

(1) HNO₃ and NH₄NO₃  (2) HClO₃ and NaClO₃  (3) HCN and NaCN  (4) NH₃ and NH₄Cl

(a) 1, 3, 4  (b) 1, 2  (c) 2, 3, 4  (d) 3, 4  (e) 1, 3

11&12. Consider 0.1 M solutions of the following weak acids:

CH₃COOH \[ K_a = 1.8 \times 10^{-5} \]

HBrO \[ K_a = 2.5 \times 10^{-9} \]

Which of the following statements is NOT correct?

(a) Acetic acid is a stronger acid than hypobromous acid.
(b) The concentration of OH⁻ ions is greater in the HBrO solution.
(c) [BrO⁻] in HBrO solution > [CH₃COO⁻] in CH₃COOH solution.
(d) [H⁺] in CH₃COOH solution > [H⁺] in HBrO solution.
(e) The pH of the CH₃COOH solution is lower than the pH of the HBrO solution.

13&14. A 0.20 M solution of a monoprotic acid is 3.7% ionized. What is the Ka for this weak acid?

(a) 1.3 \times 10^{-3}  (b) 3.7 \times 10^{-4}  (c) 3.2 \times 10^{-6}  (d) 2.9 \times 10^{-5}  (e) 2.7 \times 10^{-4}
15&16. What is the pH of a $8.2 \times 10^{-4}$ M HCl?

(a) 2.35  (b) 4.51  (c) 4.72  (d) 3.09  (e) 3.17

17&18. It is desired to buffer a solution at pH = 10.3.
What molar ratio of CH$_3$NH$_2$ to CH$_3$NH$_3$Cl should be used?.

(a) 0.88/1  (b) 0.70/1  (c) 0.12/1  (d) 2.8/1  (e) 0.40/1

19&20. Calculate the $\Delta G^\circ$ for the reaction at 25°C if the value of the thermodynamic equilibrium constant, $K_{\text{thermo}}$, is $1.00 \times 10^{-2}$? ($R = 8.314$ J/mol·K)

(a) –5.4 kJ/mol  (b) +11.4 kJ/mol  (c) +5.4 kJ/mol
(d) +95.7 kJ/mol  (e) –11.4 kJ/mol
21&22. If $K_w$ is $2.9 \times 10^{-15}$ at 10°C, what is the pH of pure water at 10°C?

(a) 6.51    (b) 7.00    (c) 7.27    (d) 7.45    (e) none of these

23&24. What is the pH of a solution that is 0.25 M NH$_4$NO$_3$?

(a) 4.93    (b) 5.50    (c) 9.16    (d) 4.32    (e) 7.00
The following 5 questions (25 – 31) deal with a single titration:

25&26. A 50.0 mL sample of 0.100 M nitrous acid is titrated with 0.200 M NaOH. Calculate the initial pH before the titration is begun. The $K_a$ for nitrous acid is on the back of the envelope.

(a) 2.17  (b) 1.58  (c) 1.00  (d) 2.39  (e) 2.04

27&28. A 50.0 mL sample of 0.100 M nitrous acid is titrated with 0.200 M NaOH. Calculate the pH after 10.0 mL of 0.200 M NaOH has been added.

(a) 2.92  (b) 3.17  (c) 3.00  (d) 3.52  (e) 3.66
(5 pts) 29. A 50.0 mL sample of 0.100 M nitrous acid is titrated with 0.200 M NaOH. Calculate the pH at the equivalence point.

(5 pts) 30. A 50.0 mL sample of 0.100 M nitrous acid is titrated with 0.200 M NaOH. Calculate the pH after 30.0 mL of 0.200 M NaOH is added.
31. A 50.0 mL sample of 0.100 M nitrous acid is titrated with 0.200 M NaOH. Using the answers to Questions 21-26, 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.

32. (a) All solutions of soluble salts and bases will become saturated if the concentrations are high enough. Write the appropriate equilibrium and the $K_{sp}$ expression for CuF$_2$(s).

(b) If 47.0 grams of CuF$_2$ will dissolve in 1.00 L of solution at 25°C, what is the $K_{sp}$ for CuF$_2$ at 25°C?
33. A solution is prepared by mixing 1.00 mol of NH₄Cl and 2.00 mol of NH₃ in a 1.00 liter container. To 100. mL of this solution is added 40.0 mL of 1.00 M HCl. What is the pH of this new solution?