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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 3 pm .
(6) There are a total of 36 questions (20 actual questions).

## PART 1

1\&2. The compound, HCIO is a: $\qquad$ .
(a) strong acid
(b) strong base
(c) weak acid
(d) weak base
(e) neutral

3\&4. 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

(a) $\mathrm{HF}+\mathrm{NaOH}$
(b) $\mathrm{HNO}_{3}+\mathrm{Ca}(\mathrm{OH})_{2}$
(c) $\mathrm{CH}_{3} \mathrm{COOH}+\mathrm{KOH}$
(d) $\mathrm{HCl}+\mathrm{NH}_{3}$
(e) $\mathrm{HClO}_{4}+\mathrm{NaOH}$

## pH at Equivalence Point

less than 7
equal to 7
more than 7
less than 7
equal to 7

5\&6. The hydrolysis constant used when finding the pH of a solution of NaCN is:
(a) $\frac{\mathrm{K}_{a} \text { for } \mathrm{HCN}}{\mathrm{K}_{\mathrm{b}} \text { for } \mathrm{CN}^{-}}$
(b) $\frac{\mathrm{K}_{\mathrm{a}} \text { for } \mathrm{HCN}}{\mathrm{K}_{\mathrm{w}}}$
(c) $\frac{\mathrm{K}_{\mathrm{w}}}{\mathrm{K}_{\mathrm{a}} \text { for } \mathrm{HCN}}$
(d) $\frac{\mathrm{K}_{\mathrm{a}} \text { for } \mathrm{Na}^{+}}{\mathrm{K}_{\mathrm{w}}}$
(e) $\frac{\mathrm{K}_{\mathrm{w}}}{\mathrm{K}_{\mathrm{a}} \text { for } \mathrm{Na}^{+}}$

7\&8. Which will be a buffer when equal volumes of the following solutions are mixed?
(a) $0.1 \mathrm{M} \mathrm{HClO}_{3}$ and $0.2 \mathrm{M} \mathrm{NaClO}_{3}$
(b) 0.1 M NaOH and 0.1 M NaF
(c) 0.1 M HCl and 0.2 M NaCl
(d) 0.1 M HCN and 0.2 M NaCN
(e) $0.1 \mathrm{M} \mathrm{NH}_{3}$ and 0.1 M NaCl

9\&10. 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) $\left[\mathrm{H}_{3} \mathrm{O}^{+}\right]=1.0 \times 10^{-7} \mathrm{M}$
(b) $\left[\mathrm{H}_{3} \mathrm{O}^{+}\right]=\left[\mathrm{OH}^{-}\right]$
(c) $\left[\mathrm{H}_{3} \mathrm{O}^{+}\right] \times\left[\mathrm{OH}^{-}\right]=1.0 \times 10^{-14}$
(d) $\mathrm{pH}=7.0$
(e) $\mathrm{pOH}+\mathrm{pH}=14.0$

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

| $\mathrm{CH}_{3} \mathrm{COOH}$ | $K_{\mathrm{a}}=1.8 \times 10^{-5}$ |
| :--- | :--- |
| HCN | $K_{\mathrm{a}}=4.0 \times 10^{-10}$ |

Which of the following statements is NOT correct?
(a) Acetic acid is a stronger acid than hydrocyanic acid.
(b) $\left[\mathrm{CN}^{-}\right]$in HCN solution $>\left[\mathrm{CH}_{3} \mathrm{COO}^{-}\right]$in $\mathrm{CH}_{3} \mathrm{COOH}$ solution.
(c) The concentration of $\mathrm{OH}^{-}$ions is greater in the HCN solution.
(d) The pH of the $\mathrm{CH}_{3} \mathrm{COOH}$ solution is lower than the pH of the HCN solution.
(e) $\left[\mathrm{H}^{+}\right]$in $\mathrm{CH}_{3} \mathrm{COOH}$ solution $>\left[\mathrm{H}^{+}\right]$in HCN solution.

13\&14. The conjugate acid of $\mathrm{HCO}_{3}^{-}$is:
(a) $\mathrm{H}_{2} \mathrm{CO}_{3}$
(b) $\mathrm{H}^{+}$
(c) $\mathrm{H}_{3} \mathrm{O}^{+}$
(d) $\mathrm{CO}_{3}{ }^{2-}$
(e) none of these

15\&16. Which equilibrium has the thermodynamic equilibrium constant expression: $\mathrm{K}_{\text {thermo }}=[X]^{3} /\left(\mathrm{p}_{\mathrm{Y}}\right)$
(a) $\mathrm{Y}(\mathrm{g}) \underset{\leftarrow}{ } \mathrm{Z}(\ell)+3 X(a q)$
(b) $3 X(a q) \underset{ }{\rightleftarrows} \mathrm{Y}(\mathrm{g})+3 Z(\mathrm{~s})$
(c) $\mathrm{Y}(\mathrm{g}) \stackrel{3 Z}{ } \stackrel{\mathrm{~g})}{ }$
(d) $\mathrm{Y}(\mathrm{aq}) \rightleftarrows 3 \mathrm{X}(\mathrm{g})$
(e) $3 X(\mathrm{~g}) \stackrel{\mathrm{Y}}{\mathrm{L}} \mathrm{aq})+3 \mathrm{Z}(\mathrm{s})$

17\&18. What is the pH of a $7.00 \times 10^{-3} \mathrm{M} \mathrm{HI}(\mathrm{aq})$ solution?
(a) 4.91
(b) 2.15
(c) 3.65
(d) 1.00
(e) 0.97

19\&20. Calculate the thermodynamic equilibrium constant at $25^{\circ} \mathrm{C}$ for a reaction for which $\Delta \mathrm{G}^{\circ}=-12.40 \mathrm{~kJ}$ per mol rxn?
(a) $3.28 \times 10^{4}$
(b) 553
(c) $7.32 \times 10^{3}$
(d) 6.20
(e) 149

21\&22. What is the percent ionization of a 0.65 M solution of $\mathrm{HNO}_{2}$ ?
(a) $2.6 \%$
(b) $1.4 \%$
(c) $3.2 \%$
(d) $2.1 \%$
(e) $3.0 \%$

23\&24. What is the pH of a 0.20 M KBrO solution?
(a) 8.65
(b) 9.40
(c) 4.62
(d) 7.85
(e) 10.95

25\&26. Calculate the pH of the solution resulting from the addition of 20.0 mL of 0.500 M HCl to 80.0 mL of 0.150 M NaOH .
(a) 7.00
(b) 2.73
(c) 11.25
(d) 12.30
(e) 11.85

27\&28. Calculate the pH that results when 35.0 mL of 1.00 M HCl is added to 500.0 mL of a solution composed of 0.100 M HCOOH and 0.300 M NaCHOO .
(a) 4.74
(b) 4.11
(c) 4.51
(d) 3.39
(e) 3.88

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

29\&30. A 60.0 mL sample of 0.300 M methylamine is titrated with 0.100 M HCl . Calculate the initial pH before the titration is begun.
(a) 13.50
(b) 11.59
(c) 11.78
(d) 12.09
(e) 12.28

OVER $\Rightarrow$

31\&32. A 60.0 mL sample of 0.300 M methylamine is titrated with 0.100 M HCl . Calculate the pH after 80.0 mL of 0.100 M HCI has been added.
(a) 10.12
(b) 9.53
(c) 10.80
(d) 10.50
(e) 10.65

CHEMISTRY 102 EXAM 3

FALL 2010 Section 501
$\qquad$
(Please blockprint)

Form A

## 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 60.0 mL sample of 0.300 M methylamine is titrated with 0.100 M HCl . Calculate the pH at the equivalence point.
(5 pts) 34. A 60.0 mL sample of 0.300 M methylamine is titrated with 0.100 M HCl . Calculate the pH after 190.0 mL of 0.100 M HCl is added.
(5 pts) 35. A 60.0 mL sample of 0.300 M methylamine is titrated with 0.100 M HCl . Using the answers to Questions 29-34, sketch the titration curve with pH on the vertical axis and milliliters of acid 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.

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36. A weak acid indicator, $\operatorname{HIn}\left(K_{a}=1.0 \times 10^{-9}\right)$ ionizes as follows:

$$
\underset{\text { blue }}{\mathrm{HIn} \underset{\text { yellow }}{\rightleftarrows}} \mathrm{H}^{+}+\mathrm{In}^{-}
$$

(2 pts) (a) The endpoint of an acid-base titration that uses this indicator will be at $\mathrm{pH}=$ $\qquad$ .
(2 pts) (b) Explain your answer to (a) using the equilibrium expression.
(1 pt) (c) The color at $\mathrm{pH}=8$ will be $\qquad$ .

## SCRAP PAPER OR COMMENTS ON EXAM

| CHEMISTRY 102 | Fall 2010 | NAME |
| :--- | :--- | :--- |
| EXAM 3 Form A | Section 501 |  |

