**AP Chemistry**
**Reaction Practice**
**Day 8**

**Name** Key - 2011
**Date** _____ **Period** _____

**For each of the following three reactions, in part (i) write a BALANCED equation and in part (ii) answer the question about the reaction. In part (i), coefficients should be in terms of lowest whole numbers.** Assume that solutions are aqueous unless otherwise indicated. Represent substances in solutions as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction.

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1. Equimolar quantities of solutions acetic acid sodium hydrogen carbonate are mixed.

(i) $HC_2H_3O_2 + HCO_3^- \rightarrow C_2H_3O_2^- + H_2O + CO_2$

(ii) Name a chemical that you could add to the resulting solution in order to form a buffer solution. Explain.

Add the weak acid $HC_2H_3O_2$ to the conjugate base of $C_2H_3O_2^-$ and you have a buffer.

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2. Solid calcium hydride is added to distilled water.

(i) $CaH_2 + 2H_2O \rightarrow Ca^{2+} + 2OH^- + 2H_2$

(ii) If the solution formed is 0.050 M then what is the resulting pH? Show your work.

$$.050\,M\,Ca(OH)_2 \left| \frac{2\,mol\,OH^-}{1\,mol\,Ca(OH)_2} \right| = .100\,mole\,OH^- \quad pOH = -\log(.1) = 1$$

So $pH = 13$

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3. Methylamine gas is bubbled into distilled water.

(i) $H_3CNH_2 + H_2O \rightleftharpoons H_3CNH_3^+ + OH^-$

(ii) List the acid and the conjugate acid in this reaction.

the acid is $H_2O$ & its conjugate base is ~~$OH^-$~~

Conjugate acid $H_3CNH_3^+$

Equil. Day 2

(1)

# AP® CHEMISTRY
# 2007 SCORING GUIDELINES

## Question 1

$$HF(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + F^-(aq) \qquad K_a = 7.2 \times 10^{-4}$$

Hydrofluoric acid, $HF(aq)$, dissociates in water as represented by the equation above.

(a) Write the equilibrium-constant expression for the dissociation of $HF(aq)$ in water.

| | |
|---|---|
| $K_a = \dfrac{[H_3O^+][F^-]}{[HF]}$ | One point is earned for the correct expression. |

(b) Calculate the molar concentration of $H_3O^+$ in a 0.40 $M$ $HF(aq)$ solution.

| | |
|---|---|
| $K_a = \dfrac{[H_3O^+][F^-]}{[HF]} = \dfrac{(x)(x)}{0.40 - x} = 7.2 \times 10^{-4}$<br>Assume $x << 0.40$, then $x^2 = (0.40)(7.2 \times 10^{-4})$<br>$x = [H_3O^+] = 0.017\ M$ | One point is earned for the correct setup (or the setup consistent with part (a)).<br>One point is earned for the correct concentration. |

$HF(aq)$ reacts with $NaOH(aq)$ according to the reaction represented below.

$$HF(aq) + OH^-(aq) \rightarrow H_2O(l) + F^-(aq)$$

A volume of 15 mL of 0.40 $M$ $NaOH(aq)$ is added to 25 mL of 0.40 $M$ $HF(aq)$ solution. Assume that volumes are additive.

(c) Calculate the number of moles of $HF(aq)$ remaining in the solution.

| | |
|---|---|
| mol $HF(aq)$ = initial mol $HF(aq)$ – mol $NaOH(aq)$ added<br>= (0.025 L)(0.40 mol $L^{-1}$) – (0.015 L)(0.40 mol $L^{-1}$)<br>= 0.010 mol – 0.0060 mol = 0.004 mol | One point is earned for determining the initial number of moles of HF and $OH^-$.<br>One point is earned for setting up and doing correct subtraction. |

(d) Calculate the molar concentration of $F^-(aq)$ in the solution.

| | |
|---|---|
| mol $F^-(aq)$ formed = mol $NaOH(aq)$ added = 0.0060 mol $F^-(aq)$<br>$\dfrac{0.0060 \text{ mol } F^-(aq)}{(0.015 + 0.025) \text{ L of solution}} = 0.15\ M\ F^-(aq)$ | One point is earned for determining the number of moles of $F^-(aq)$.<br>One point is earned for dividing the number of moles of $F^-(aq)$ by the correct total volume. |

Equil. Day 2

(2)



**Question 1 (continued)**

(e) Calculate the pH of the solution.

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|---|---|
| $[HF] = \frac{0.004 \text{ mol HF}}{0.040 \text{ L}} = 0.10\,M \text{ HF}$<br><br>$K_a = \frac{[H_3O^+][F^-]}{[HF]} \Rightarrow \frac{[HF] \times K_a}{[F^-]} = [H_3O^+]$<br><br>$\Rightarrow \frac{0.10\,M\,(7.2 \times 10^{-4})}{0.15\,M} = 4.8 \times 10^{-4}$<br><br>$\Rightarrow \text{pH} = -\log(4.8 \times 10^{-4}) = 3.32$<br><br>**OR**<br><br>$\text{pH} = \text{p}K_a + \log\frac{[F^-]}{[HF]}$<br><br>$= -\log(7.2 \times 10^{-4}) + \log\frac{0.15\,M}{0.10\,M}$<br><br>$= 3.14 + 0.18$<br><br>$= 3.32$ | One point is earned for indicating that the resulting solution is a buffer (e.g., by showing a ratio of $[F^-]$ to $[HF]$ or moles of $F^-$ to $HF$).<br><br>One point is earned for the correct calculation of pH. |