Chapter 13 & 14 – Review Set

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1. Calculate:

   (a) pH when $\left[OH^-\right] = 2.3 \cdot 10^{-6}$

   $$-\log_{10}\left(\frac{1 \cdot 10^{-14}}{2.3 \cdot 10^{-6}}\right) = 8.36 \tag{1}$$

   (b) pOH when $\left[H_3O^+\right] = 2.8 \cdot 10^{-8}$

   $$-\log_{10}\left(\frac{1 \cdot 10^{-14}}{2.8 \cdot 10^{-8}}\right) = 6.45 \tag{2}$$

   (c) $[H_3O^+]$ when pH is 8.53

   $$10^{-8.53} = 2.95 \cdot 10^{-9}\,[\text{M}] \tag{3}$$

   (d) $[OH^-]$ when pH is 2.36

   $$\frac{1 \cdot 10^{-14}}{10^{-2.36}} = 2.29 \cdot 10^{-12}\,[\text{M}] \tag{4}$$

2. Write the dissociation equation:

   (a) $HBr \longrightarrow H^+ + Br^-$
   (b) $F^- + H_2O \longrightarrow HF + OH^-$
   (c) $HC_2H_5O \longrightarrow H^+ + C_2H_5O^-$
   (d) $HClO_4 \longrightarrow H^+ + {ClO_4}^-$
   (e) $HNO_2 \longrightarrow H^+ + {NO_2}^-$

(f) $PO_4{}^{3-} + H_2O \longrightarrow HPO_4{}^{2-} + OH^-$

3.

$$\begin{aligned} \frac{x^2}{1.5} &= .00014 \\ x &= .0145[\mathrm{M}] \end{aligned} \tag{5}$$

4.

$$\begin{aligned} \frac{x^2}{.126} &= 1.5 \cdot 10^{-9} \\ x &= \sqrt{.126 \cdot 1.5 \cdot 10^{-9}} \\ 14 + \log_{10}(x) &= 9.14 \end{aligned} \tag{6}$$

5.

$$\begin{aligned} [\mathrm{H}^+] &= 10^{-9.8} = 1.585 \cdot 10^{-10} \\ [\mathrm{OH}^-] &= 6.31 \cdot 10^{-5} \\ \frac{(6.31 \cdot 10^{-5})^2}{.0278} &= 1.432 \cdot 10^{-7}\,[\mathrm{M}] \end{aligned} \tag{7}$$

6. $H_2PO_4{}^- + OH^- \longrightarrow HPO_4{}^{2-} + H_2O$

$$\begin{aligned} \text{Lost: } .5 \cdot .3 - .137 \cdot .42 &= .09246[\mathrm{mol}] \\ \text{Gain: } .137 \cdot .42 + .05 &= .1075[\mathrm{mol}] \\ [\mathrm{H}^+] &= \frac{(6.2 \cdot 10^{-8})\left(\frac{.09246}{.3+.42}\right)}{\frac{.1075}{.3+42}} \\ &= 5.33 \cdot 10^{-8} \\ -\log_{10}\left(5.33 \cdot 10^{-8}\right) &= 7.27 \end{aligned} \tag{8}$$

7. (a)

$$\begin{aligned} .006 \cdot .532 &= .003192[\mathrm{mol}] \\ .032 \cdot .201 = .006432 - .003192 &= .00324[\mathrm{mol}] \\ [\mathrm{H}^+] &= \frac{(1.5 \cdot 10^{-5})(.00324)}{.003192} \\ &= 1.52 \cdot 10^{-5} \\ \mathrm{pH} &= 4.817 \end{aligned} \tag{9}$$

(b)

$$\begin{aligned} V_b &= \frac{.032 \cdot .201}{.532} \\ &= .0121[\text{L}] \\ .0121 \cdot .532 &= .006432[\text{mol}] \\ \frac{.006432}{.0121 + .032} &= .14585[\text{M}] \\ \text{Kb} = \frac{10^{-14}}{1.5 \cdot 10^{-5}} &= 6.67 \cdot 10^{-10} \\ x = \sqrt{.14585 \cdot 6.67 \cdot 10^{-10}} &= 9.86 \cdot 10^{-6}[\text{M}] \\ \text{pH} = 14 + \log_{10}\left(9.86 \cdot 10^{-6}\right) &= 9 \end{aligned} \tag{10}$$

8. (a)

$$\begin{aligned} .094 \cdot .1035 &= .009729[\text{mol}] \\ .044 \cdot .332 = .014608 - .009729 &= .004879[\text{mol}] \\ [\text{OH}^-] = \frac{(5.6 \cdot 10^{-10})(.004879)}{.009729} &= 2.808 \cdot 10^{-10} \\ \text{pH} &= 4.45 \end{aligned} \tag{11}$$

(b)

$$\begin{aligned} V_b &= \frac{.044 \cdot .332}{.1035} \\ &= .141[\text{L}] \\ .141 \cdot .1035 &= .0146[\text{mol}] \\ \frac{.0146}{.141 + .044} &= .0789[\text{M}] \\ \text{Ka} = \frac{10^{-14}}{5.6 \cdot 10^{-10}} &= 1.786 \cdot 10^{-5} \\ x = \sqrt{.0789 \cdot 1.786 \cdot 10^{-5}} &= .00119[\text{M}] \\ \text{pH} = -\log_{10}(.00119) &= 2.924 \end{aligned} \tag{12}$$

9. (a)

$$\begin{aligned} x &= \sqrt{.178 \cdot 1.9 \cdot 10^{-4}} \\ &= .00582[\text{M}] \\ -\log_{10}(.00582) &= 2.24 \end{aligned} \tag{13}$$

(b)

$$\begin{aligned} .0048 \cdot .523 &= .00251[\text{mol}] \\ .03 \cdot .178 = .00534 - .00251 &= .00283[\text{mol}] \\ [\text{H}^+] &= \frac{\left(1.9 \cdot 10^{-4}\right)(.00283)}{.00251} \\ \text{pH} &= 3.67 \end{aligned} \tag{14}$$

10. (a)

$$\begin{aligned} x &= \sqrt{.244 \cdot 7.14 \cdot 10^{-11}} \\ &= 4.174 \cdot 10^{-6} \\ 14 + \log_{10}\left(4.174 \cdot 10^{-6}\right) &= 8.621 \end{aligned} \tag{15}$$

(b)

$$\begin{aligned} .078 \cdot .1033 &= .00806[\text{mol}] \\ .05 \cdot .244 = .0122 - .00806 &= .00414[\text{mol}] \\ [\text{H}^+] &= \frac{\left(7.14 \cdot 10^{-11}\right)(.00414)}{.00806} \\ \text{pH} &= 3.56 \end{aligned} \tag{16}$$

(c)

$$\begin{aligned} V_b &= \frac{.05 \cdot .244}{.1033} \\ &= .1181[\text{L}] \\ .1181 \cdot .1033 &= .0122[\text{mol}] \\ \frac{.0122}{.1181 + .05} &= .0726[\text{M}] \\ \text{Ka} &= \frac{10^{-14}}{7.14 \cdot 10^{-11}} \\ &= 1.4 \cdot 10^{-4} \\ x &= \sqrt{.0726 \cdot 1.4 \cdot 10^{-4}} \\ &= .003189 \\ -\log_{10}(.003189) &= 2.5 \end{aligned} \tag{17}$$