Chapter 14 – Problem Set 1

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1. (a)

$$\begin{aligned} [\mathrm{H}^+] &= 4\left(4.7 \cdot 10^{-11}\right) \\ &= 1.88 \cdot 10^{-10} \\ -\log_{10}\left(1.88 \cdot 10^{-10}\right) &= 9.725 \end{aligned} \tag{1}$$

(b)

$$\begin{aligned} \frac{[\mathrm{HCO_3}^-]}{[\mathrm{H}^+][{\mathrm{CO_3}}^{2-}]} &= \frac{1}{4.7 \cdot 10^{-11}} \\ \frac{[\mathrm{HCO_3}^-]}{[{\mathrm{CO_3}}^{2-}]} &= \frac{10^{-10.83}}{4.7 \cdot 10^{-11}} \\ &= .315 \end{aligned} \tag{2}$$

2. $\mathrm{H}^+(\mathrm{aq}) + \mathrm{OH}^-(\mathrm{aq}) \longrightarrow \mathrm{H_2O}$

(a)

$$\begin{aligned} .02 \cdot .5 &= .01[\mathrm{mol_{HCl}}] \\ .00745 \cdot .5 &= .003725[\mathrm{mol_{OH^-}}] \\ .01 - .003725 &= .006275[\mathrm{mol_{HCl}}] \\ -\log_{10}\left(\frac{.006275}{.02745}\right) &= .641 \end{aligned} \tag{3}$$

(b)

$$\begin{aligned} .02 \cdot .5 &= .01[\mathrm{mol_{HCl}}] \\ .0185 \cdot .5 &= .00925[\mathrm{mol_{OH^-}}] \\ .01 - .00925 &= .00075[\mathrm{mol_{HCl}}] \\ -\log_{10}\left(\frac{.00075}{.0385}\right) &= 1.71 \end{aligned} \tag{4}$$

(c)

$$\begin{aligned} .02 \cdot .5 &= .01[\text{mol}_{\text{HCl}}] \\ .02035 - .02 &= .00035[\text{mL}_{\text{OH}^-}] \\ .00035 \cdot .5 &= .000175[\text{mol}_{\text{OH}^-}] \\ 14 + \log_{10}\left(\frac{.000175}{.04035}\right) &= 11.64 \end{aligned} \tag{5}$$

3. (a)

$$-\log_{10}\left(\frac{4}{5} \cdot 1.8 \cdot 10^{-5}\right) = 4.84 \tag{6}$$

(b)

$$4.84 - \log_{10}\left(\frac{.04 - .01}{.05 + .01}\right) = 5.14 \tag{7}$$

(c)

$$4.84 - \log_{10}\left(\frac{.04 + .01}{.05 - .01}\right) = 4.74 \tag{8}$$

4. (a)

$$-\log_{10}\left(\frac{.025(.1) - .0113(.2)}{.025 + .0113}\right) = 2.18 \tag{9}$$

(b)

$$\begin{aligned} -\log_{10}\left(\frac{.025(.1) - .0125(.2)}{.025 + .0125}\right) &\text{ is undefined} \\ \text{This means pH } &= 7 \end{aligned} \tag{10}$$

(c)

$$\begin{aligned} .0138(.2) - .025(.1) &= .00026\,[\text{mol}_{\text{OH}^-}] \\ 14 + \log_{10}\left(\frac{.00026}{.025 + .0138}\right) &= 11.82 \end{aligned} \tag{11}$$

5.

$$\begin{aligned} .132 \cdot 500 \cdot .943 &= 62.238[\text{g}_{\text{NH}_3}] \\ \frac{62.238}{17} &= 3.66[\text{mol}_{\text{NH}_3}] \\ \frac{x}{3.66} \cdot 5.6 \cdot 10^{-10} &= 10^{-9.45} \\ \frac{x}{3.66} &= .634 \\ x &= 3.66 \cdot .634 \\ &= 2.32[\text{mol}_{\text{NH}_4\text{Cl}}] \\ 2.32 \cdot 53 &= 123[\text{g}] \end{aligned} \tag{12}$$