

Acid/base practice problems (calculator required)

1) Calculate the pH and pOH (at 25°C, where  $K_w = 1.0 \times 10^{-14}$ ) of the following mixtures:

- 25.00 mL of 0.02015 M  $\text{Ca}(\text{OH})_2$  and 12.75 mL of 0.04182 M HBr.  
**[pH = 12.10, pOH = 1.90]**
- 25.00 mL of 1.000 M HF ( $K_a = 3.53 \times 10^{-4}$ ). **[pH = 1.73, pOH = 12.27]**
- 25.00 mL of 1.000 M HF and 5.00 mL of 1.25 M NaOH. **[2.98/11.02]**
- 25.00 mL of 1.000 M HF and 10.00 mL of 1.25 M NaOH **[3.45/10.55]**
- 25.00 mL of 1.000 M HF and 15.00 mL of 1.25 M NaOH **[3.93/10.07]**
- 25.00 mL of 1.000 M HF and 20.00 mL of 1.25 M NaOH **[8.60/5.40]**
- 25.00 mL of 1.000 M HF and 25.00 mL of 1.25 M NaOH **13.10/0.90]**
- 25.00 mL of 1.000 M  $\text{H}_2\text{SO}_4$ .  $K_{a2}$  for  $\text{H}_2\text{SO}_4 = 1.1 \times 10^{-2}$  **[-0.005/14.005]**
- 10.00 mL of 1.000 M  $\text{NH}_3$  ( $K_b = 1.75 \times 10^{-5}$ ) **[11.62/2.38]**
- 10.00 mL of 1.000 M  $\text{NH}_3$  and 5.00 mL of 1.000 M HCl **[9.24/4.76]**
- 10.00 mL of 1.000 M  $\text{NH}_3$  and 10.00 mL of 1.000 M HCl **[4.77/9.23]**
- 10.00 mL of 1.000 M  $\text{NH}_3$  and 15.00 mL of 1.000 M HCl **[0.70/13.30]**

2) Calculate the ratio of  $[\text{H}_3\text{PO}_4]:[\text{H}_2\text{PO}_4^-]:\{\text{HPO}_4^{2-}\}:[\text{PO}_4^{3-}]$  in a solution with a pH of 7. If you were going to make a buffer of pH 7.00 and only allowed to use two of  $\text{H}_3\text{PO}_4$ ,  $\text{NaH}_2\text{PO}_4$ ,  $\text{Na}_2\text{HPO}_4$ , and  $\text{Na}_3\text{PO}_4$ , which would you pick? **[5.32 : 3.78 x 10<sup>5</sup> : 2.38 x 10<sup>5</sup> : 1]**

3) A certain indicator has a  $\text{pK}_{\text{ind}} = 2.30$ . You use it in the titration of 10.00 mL of 0.1000 M HCl with 0.1000 M NaOH. At what added volume of NaOH will the indicator change colour? Does this make it a good or a bad indicator for this titration? **[9.05 mL, no]**

4) Calculate the pH of a  $5.0 \times 10^{-9}$  M solution of HCl (at 25°C, where  $K_w = 1.0 \times 10^{-14}$ ) **[6.989]**.

*The next question is **extremely** difficult. It is of bonus-question caliber and should not be attempted until all other questions have been answered correctly.*

5)  $\text{H}_2\text{SO}_4$  has a  $K_{a2}$  of  $1.1 \times 10^{-2}$ . How many mL of 1.000 M  $\text{Na}_2\text{SO}_4$  must be added to 800.0 mL of 0.5000 M  $\text{H}_2\text{SO}_4$  to create a buffer of pH 1.75? **[847.4]**