

**CH302 Worksheet 8**—How to Systematically Work Harder and Harder Acid Base Calculations Exactly the Same Way: Proof that the **Seven Steps to Solving Acid Base Problems** Work

- 1 Remove the spectator ions
- 2 Are there any strong acids or bases
- 3 Are there any weak acids or bases
- 4 Do I neutralize (are there both acids and bases and is at least one of them strong?)
- 5 Neutralize: convert everything to moles, write down neutralization reaction, perform limiting reagent calculation, convert back to molarity if necessary)
- 6 Select the appropriate acid base calculation and solve
- 7 Convert to appropriate final form (pH, pOH, H<sup>+</sup>, OH<sup>-</sup>) using  $14 = \text{pH} + \text{pOH}$  and  $14 = \text{pK}_a + \text{pK}_b$

**Important: These calculations are based upon the following important assumptions:**

- Strong acids and bases completely dissociate
- Weak acids and bases do not dissociate significantly (typically they will have K values  $< 10^{-3}$ )
- The dissociation of water does not contribute significantly to pH (concentrations of dissolved solutions are large,  $> 10^{-4}$ , and the K values are not near  $K_w$ ,  $> 10^{-11}$ )

In a nutshell, all of these problems are worked at high concentrations for a single equilibrium. When we get to complex equilibria you will learn how to tackle problems for which the assumptions do not hold.

1. What is the pOH of a 0.1 M HClO<sub>4</sub> solution?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

2. What is the pH of a 0.1 M RbOH solution?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

3. What is the [H<sup>+</sup>] of a 0.1 M malonic acid with a K<sub>a</sub> of 10<sup>-9</sup> solution?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

4. What is the pH of a 0.1 M lithium malonate solution? (Need a  $K_b$ ? Look at the problem above.)

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

5. What is the  $[OH^-]$  of a 0.01 M methylamine solution of  $K_b = 10^{-6}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

6. What is the pOH of a 0.01 M  $CH_3NH_3Br$  solution? (Need a  $K_a$ ? Look at the problem above.)

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

7. What is the pH when equal volume mixtures of 0.2 M  $HClO_4$  and 0.2M  $LiClO_4$  are mixed?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

8. What is the pH when 100 ml of 0.1 M  $\text{HClO}_4$  and 50 ml of 0.1 M  $\text{Ba}(\text{OH})_2$  are mixed?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

9. What is the pH when 1 liter of 0.1 M  $\text{HClO}_4$  and 1 liter of 0.5M  $\text{Ba}(\text{OH})_2$  are mixed? (this is the first problem to need a calculator)

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

10. What is the pOH when 100 ml of 0.1 M malonic acid and 100 ml of 0.1 M sodium malonate are mixed?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

10. What is the pH when 100 ml of 0.1 M methylamine and 100 ml of 0.1 M  $\text{CH}_3\text{NH}_3\text{Br}$  are mixed?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

**The next four calculations represent the titration of a weak base with a strong acid. Note the pH gets smaller and smaller as more acid is added.**

11. What is the pH when no HBr is added to 100 ml of 0.1 M sodium malonate?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

12. What is the pH when 50 ml of 0.1 M HBr is added to 100 ml of 0.1 M sodium malonate?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

13. What is the pH when 100 ml of 0.1 M HBr is added to 100 ml of 0.1 M sodium malonate?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

14. What is the pH when 110 ml of 0.1 M HBr is added to 100 ml of 0.1 M sodium malonate?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

**The next four calculations represent the titration of a weak acid with a strong base. Note the pH gets larger and larger as more base is added.**

15. What is the pH when no LiOH is added to 200 ml of 0.05 M  $\text{CH}_3\text{NH}_3\text{Br}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

16. What is the pH when 100 ml of 0.05 M LiOH is added to 200 ml of 0.05 M  $\text{CH}_3\text{NH}_3\text{Br}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

17. What is the pH when 200 ml of 0.05 M LiOH is added to 200 ml of 0.05 M  $\text{CH}_3\text{NH}_3\text{Br}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

18. What is the pH when 250 ml of 0.05 M LiOH is added to 200 ml of 0.05 M  $\text{CH}_3\text{NH}_3\text{Br}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

19. What is the pH when 10 ml of 0.1 M  $\text{HClO}_3$  is added to 100 ml of 0.1 M methylamine and 100 ml of 0.1 M  $\text{CH}_3\text{NH}_3\text{Br}$ ?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

20. What is the pOH when 20 ml of 0.001 M KOH is added to 200 ml of 0.01 M malonic acid and 200 ml of 0.02 M sodium malonate are mixed?

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.

**Super-duper do it in your head pH problem.** What is the pH when 10 ml of 0.1 M  $\text{HClO}_3$  and 20 ml of 0.05M  $\text{Ba}(\text{OH})_2$  are added to 150 ml of 0.1 M methylamine and 75 ml of 0.2 M  $\text{CH}_3\text{NH}_3\text{Br}$ ? Hint, put away your calculator and do it in your head.

- 1
- 2
- 3
- 4
- 5
- 6
- 7

What kind of acid base problem was this? \_\_\_\_\_.