

Spring 2009 CH302 Worksheet 5—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⁺, OH⁻) 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 HClO₄ 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⁺] of a 0.1 M malonic acid with a K_a of 10^{-9} 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 $[\text{OH}^-]$ 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 $\text{CH}_3\text{NH}_3\text{Br}$ 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 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 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 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 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? _____.