

Acid Base Comprehensive Review Packet (2011)

General Information:

What is meant by the term *spectator ion*?

What is the difference between a strong and weak acid?

What is the difference between a strong and weak base?

What is the Bronsted Lowry definition of an acid?

What is the Bronsted Lowry definition of a base?

The bicarbonate ion (HCO_3^{-1}) is an amphoteric ion. Write a reaction with water showing how it can act as a base and then show how it can react like an acid with water.



Reacting as a base with water



Reacting as an acid with water

What is an *equivalence point* of an acid-base titration experiment?

There are many acid-base indicators that can be used. What factor do chemists use to decide which indicator would be appropriate for their acid-base titration?

What is the estimated pH at the equivalence point of a titration involving a weak acid and a strong base?

- (a) pH < 7.0
- (b) pH = 7.0
- (c) pH > 7.0

What is a buffer?

How do we know when to draw a single arrow (irreversible) or double arrow in chemical reactions?

Which is a stronger acid: HBrO₃ or HBrO ? Explain briefly.

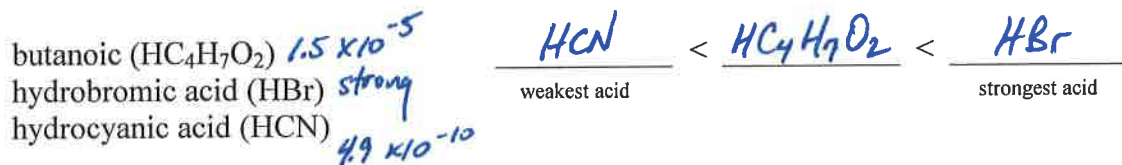
MORE OXYGENS = STRONGER ACID

How would you prepare a 125 mL of 0.44 M HCl solution from concentrated 12 M HCl solution? Explain briefly and show any necessary calculations.

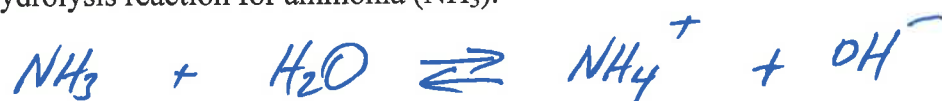
$$(.44)(.125) = (12)(V)$$

V = .0046 Liters or 4.6 mL conc. HCl added to about 50 mL H₂O then mix. Add H₂O to final volume

Use the orange sheet of K_a values to rank the following three acids in order from weakest to strongest:



Write the hydrolysis reaction for ammonia (NH₃).



Consider the above hydrolysis equation in this question. What happens to the position of the equilibrium (shift left, right, or no effect) if 6 M NaOH is added to the equilibrium system?

OH⁻ addn shifts to the left (LeChat Principle)

Strong Acid/Base Problems

1. What is the pH of a 0.10 M HBr solution?

$$-\log(.10) = \text{pH}$$

$$\text{pH} = 1$$

2. What is the pH of a 0.15 M NaOH solution?

$$-\log(.15) = \text{pOH}$$

$$\text{pOH} = .82$$
$$\text{pH} = 13.18$$

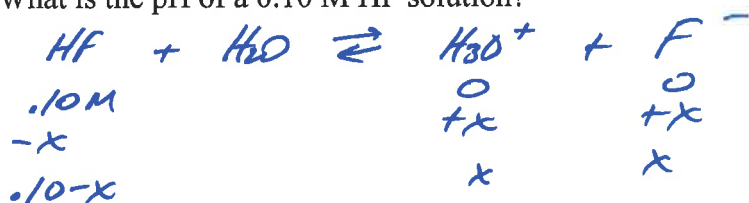
3. What is the pH of a 0.10 M Ca(OH)₂ solution?

$$-\log(.20) = \text{pOH}$$

$$\text{pOH} = .699$$
$$\text{pH} = 13.30$$

Weak Acid/Base Problems

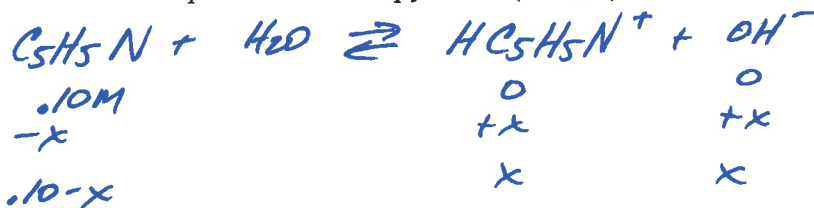
4. What is the pH of a 0.10 M HF solution?



$$K_a = 6.8 \times 10^{-4} = \frac{x^2}{.10-x}$$

$$x = .0079$$
$$\text{pH} = 2.10$$

5. What is the pH of a 0.10 M pyridine (C₅H₅N) solution?



$$K_b = 1.7 \times 10^{-9} = \frac{x^2}{.10-x}$$

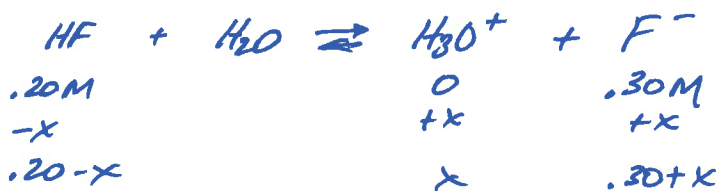
$$x = [\text{OH}^-] = 1.3 \times 10^{-5} \text{ M}$$

$$\text{pOH} = 4.88$$

$$\text{pH} = 9.11$$

Buffer Problems

6. What is the pH of a solution that is 0.20 M in HF and 0.30 M in NaF?

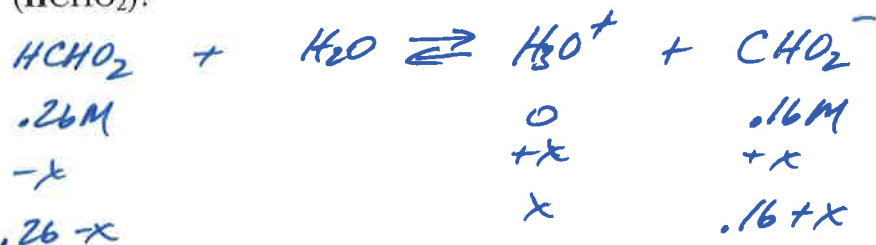


$$K_a = 6.8 \times 10^{-4} = \frac{[x][.30+x]}{[.20-x]}$$

$$x = 4.52 \times 10^{-4} = [\text{H}_3\text{O}^+]$$

$$\text{pH} = 3.35$$

7. What is the pH of a solution that is 0.16 M in sodium formate (NaCHO₂) and 0.26 M in formic acid (HCHO₂)?



$$\text{pH} = 3.54$$

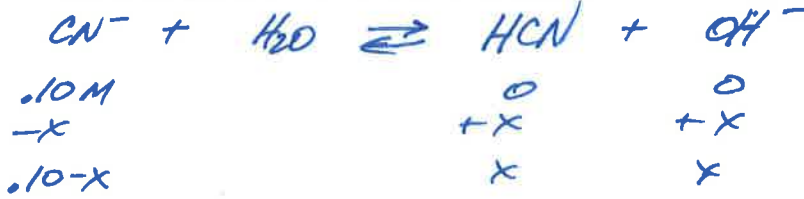
$$K_a = 1.8 \times 10^{-4} = \frac{[x][.16+x]}{[.26-x]}$$

$$x = 2.9 \times 10^{-4} = [\text{H}_3\text{O}^+]$$

Hydrolysis Problems

8. What is the pH of a 0.10 M NaCN solution?

$$K_b = \frac{1 \times 10^{-14}}{4.9 \times 10^{-10}} = 2.0 \times 10^{-5}$$

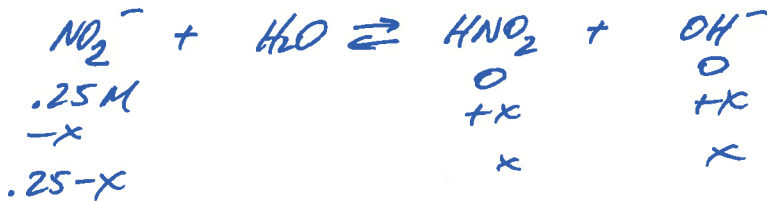


$$2.0 \times 10^{-5} = \frac{x^2}{[.10-x]}$$

$$x = [\text{OH}^-] = .0014\text{M}$$

$\text{pOH} = 2.85$ $\text{pH} = 11.15$

9. What is the pH of a 0.25 M KNO₂ solution?



$$K_b = \frac{1 \times 10^{-14}}{4.5 \times 10^{-4}} = 2.2 \times 10^{-11}$$

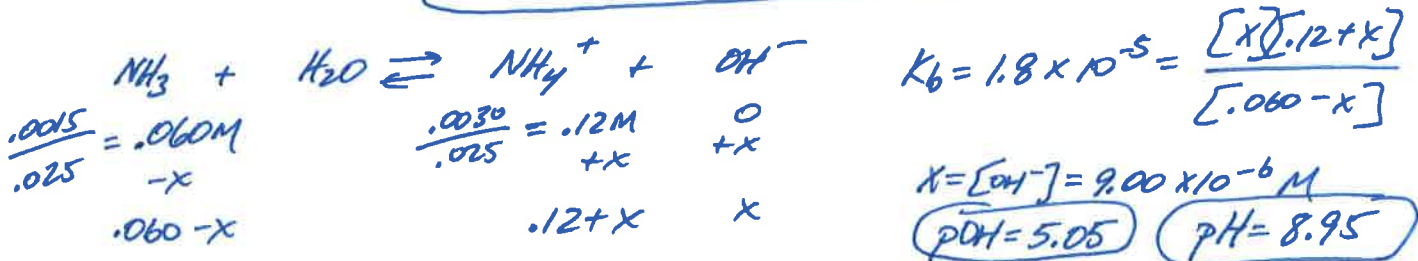
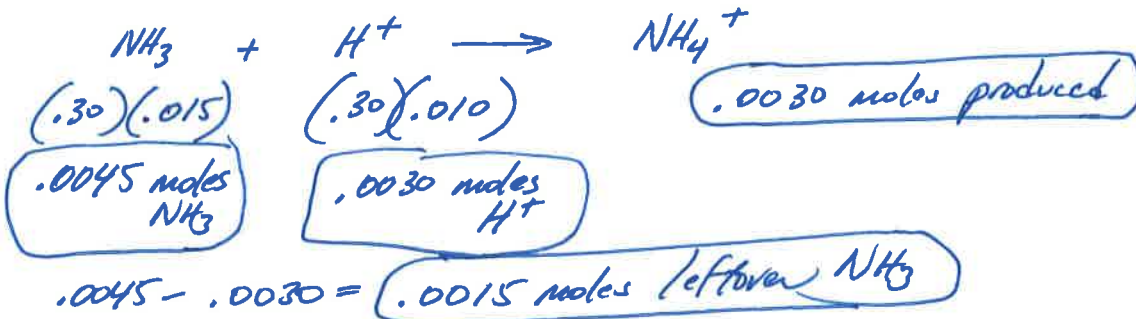
$$2.2 \times 10^{-11} = \frac{x^2}{[.25-x]}$$

$$x = [\text{OH}^-] = 2.3 \times 10^{-6}\text{M}$$

$\text{pOH} = 5.63$
 $\text{pH} = 8.37$

Titration Problems

10. What is the pH of a solution after 10 mL of 0.30 M HCl has been added to 15 mL of 0.30 M NH₃?



11. What is the pH of the resulting solution after 15 mL of 0.20 M NaOH has been added to a beaker containing 35 mL of 0.50 M benzoic acid (HC₇H₅O₂)?

