

Chemistry 12
Acid - Base #2, Pretest

1. Which of the following species is amphiprotic?
- CN^-
 - HCl
 - HCO_3^-
 - H_2SO_4
2. A student tests a 0.10 M solution with different pH indicators and finds that:
- alizarin yellow remains yellow in the solution. $\text{pH} < 10.1$
 - thymol blue remains blue in the solution. $\text{pH} > 9.6$
- As a result of these observations it is correct to say the solution is a
- weak base
 - weak acid
 - strong base $\rightarrow \text{pH} = 13$
 - strong acid $\rightarrow \text{pH} = 1$
3. What is the pH of a 1.0 M AlCl_3 solution?
- 11.57
 - 7.00
 - 3.40
 - 2.43
- $K_a = 1.4 \times 10^{-5}$
4. In which of the following equations is water acting as a Brønsted-Lowry base?
- $\text{NaOH} + \text{H}_2\text{O} \rightleftharpoons \text{Na}^+ + \text{OH}^- + \text{H}_2\text{O}$
 - $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$
 - $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
 - $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{HPO}_4^{2-} + \text{H}_3\text{O}^+$
5. The indicator HIn has a yellow acid form and a red base form. The equation for its ionization is:
- $$\text{HIn} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{In}^-$$
- When KOH is added to the above system, the equilibrium
- shifts left and the solution turns red
 - shifts left and the solution turns yellow
 - shifts right and the solution turns red
 - shifts right and the solution turns yellow
6. Which of the following substances is a salt that produces an acidic aqueous solution?
- KNO_3
 - Na_2CO_3
 - NH_4NO_3
 - NaOH
7. Consider the following data:
- Solution A has a $\text{pH} = 2.0$
Solution B has a $\text{pH} = 5.0$
- By what factor is the $[\text{H}_3\text{O}^+]$ in solution B different from that in solution A?
- smaller by a factor of 3
 - greater by a factor of 3
 - smaller by a factor of 10^3
 - greater by a factor of 10^3

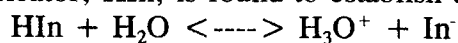
8. Consider the following equilibrium expression:

$$K_{eq} = \frac{[OH^-][H_2PO_4^-]}{[HPO_4^{2-}]}$$

The above K_{eq} expression represents the

- A. K_a expression for the dihydrogen phosphate ion
B. K_b expression for the dihydrogen phosphate ion
C. K_a expression for the monohydrogen phosphate ion
D. K_b expression for the monohydrogen phosphate ion
9. The value of K_b for $Fe(H_2O)_5(OH)^{2+}$ is
A. 1.7×10^{-14}
B. 1.7×10^{-12} $\frac{1 \times 10^{-14}}{6.0 \times 10^{-3}}$
C. 6.0×10^{-3}
D. 1.7×10^2
10. Which of the following is a salt that dissolves in water to form an acidic solution?
A. NH_4CH_3COO
B. $CrCl_3$
C. K_3PO_4
D. $Ca(C_6H_5COO)_2$
11. During a titration, a 25.00 mL sample of 0.40 M NaOH requires 20.00 mL of $H_2C_2O_4$ solution to reach the equivalence (stoichiometric) point. What is the concentration of the acid?
A. 0.80 M
B. 0.50 M
C. 0.40 M
D. 0.25 M
12. Consider the equilibrium: $HX^- + HB^- \rightleftharpoons H_2B + X^{2-}$
If the products are favoured, what is the formula of the strongest base?
A. HB^-
B. HX^-
C. H_2B
D. X^{2-}
13. A vinegar solution is reported to be 6.0% pure. If a 10.0 mL sample of the vinegar solution (density 1.0 g/mL) is titrated against 0.500 M NaOH to the equivalence point, what volume of base will be required?
A. 40 mL
B. 20 mL
C. 12 mL
D. 2.0 mL
14. Which of the following sets of salts is ordered according to increasing pH?
A. $CaCO_3$, CsF, KNO_2 , $NaClO_4$
B. $NaClO_4$, CsF, KNO_2 , $CaCO_3$
C. $CaCO_3$, KNO_2 , CsF, $NaClO_4$
D. $NaClO_4$, KNO_2 , CsF, $CaCO_3$
15. Which equation shows the acid form of an indicator HIn reacting in a basic solution?
A. $In^- + H_3O^+ \rightleftharpoons HIn + H_2O$
B. $In^- + OH^- \rightleftharpoons HIn + O^{2-}$
C. $HIn + H_2O \rightleftharpoons In^- + H_3O^+$
D. $HIn + OH^- \rightleftharpoons In^- + H_2O$

16. An indicator undergoes transition from colourless to blue at pH 10.0. What is the K_a of the indicator?
- A. 10^{-14}
 B. 10^{-10}
 C. 10^{-4}
 D. 10^{10}
17. The following indicators were added to separate samples of a solution, giving the following results:
- | | | |
|------------------|---|------------|
| bromthymol blue | = | green |
| phenolphthalein | = | colourless |
| methyl red | = | yellow |
| chlorophenol red | = | red |
| phenol red | = | yellow |
- The pH of the solution is approximately
- A. 8.2
 B. 6.8
 C. 6.1
 D. 5.4
18. Which of the following indicators is the strongest acid?
- A. orange IV
 B. alizarin yellow
 C. indigo carmine
 D. methyl violet
19. The indicator "macho pink" has a K_a of 6.7×10^{-7} . The indicator has a pink acid form and a blue base form. What is the result of adding macho pink indicator to a solution of pH 9?
- A. the solution is pink
 B. the solution is blue
 C. the [acid form] > [base form]
 D. the transition colour purple form
20. When the salt NH_4HSO_4 is dissolved in water
- A. one ion only hydrolyzes and $\text{pH} < 7$
 B. both ions hydrolyze and $\text{pH} > 7$
 C. both ions hydrolyze and $\text{pH} = 7$
 D. both ions hydrolyze and $\text{pH} < 7$
21. Which of the following substances is a salt that produces a basic solution?
- A. KBr
 B. NH_3
 C. NH_4Cl
 D. Na_3PO_4
22. An indicator, HIn, is found to establish the following equilibrium:



When the indicator was added to solutions of various pH values, the following data were recorded:

pH 6	pH 8	pH 10	pH 12
yellow	yellow	green	blue

At pH 10:

- A. $[\text{H}_3\text{O}^+] = K_a$
 B. $[\text{H}_3\text{O}^+] = \text{pH}$
 C. $[\text{H}_3\text{O}^+] = [\text{In}^-]$
 D. $[\text{H}_3\text{O}^+] = [\text{HIn}]$

23. Which of the following will have the greatest $[H_3O^+]$?
- A. 0.1 M NaF
 (B) 0.1 M NaIO₃
 C. 0.1 M Na₂SO₃
 D. 0.1 M NaCH₃COO
24. The approximate K_a value of thymolphthalein indicator is
- (A) 1×10^{-10}
 B. 1×10^{-4}
 C. 4
 D. 10
25. The value of the K_b for $HC_6H_5O_7^{2-}$ is
- (A) 5.9×10^{-10}
 B. 2.4×10^{-8}
 C. 4.1×10^{-7}
 D. 1.7×10^{-5}

Open Ended. Calculations need to be done to the correct significant figure for full marks.

1. Calculate the pH of

- (a) the strong acid, 0.25 M HBr

$$[H_3O^+] = 0.25 M$$

$$pH = -\log(0.25) = 0.60$$

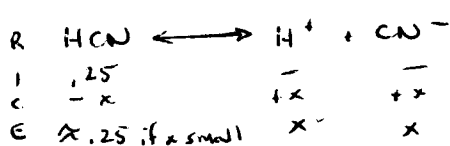
- (b) the strong base, 0.25 M KOH

$$[OH^-] = 0.25 M$$

$$pOH = -\log(0.25) = 0.60$$

$$pH = 14.00 - 0.60 = 13.40$$

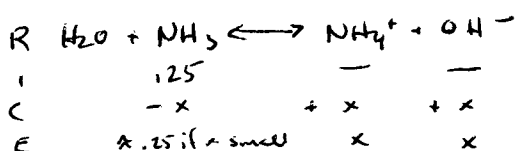
- (c) the weak acid, 0.25 M HCN



$$K_a = \frac{[H^+][CN^-]}{[HCN]} = \frac{x^2}{.25} = 4.9 \times 10^{-10}$$

$$x = [H^+] = 1.11 \times 10^{-5} M \quad pH = 4.96$$

- (d) the weak base, 0.25 M NH₃

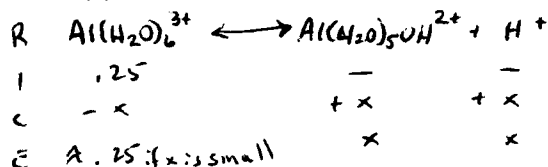


$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.79 \times 10^{-5}$$

$$= \frac{x^2}{.25} \quad x = [OH^-] = 2.11 \times 10^{-3} M$$

$$pOH = 2.675 \quad pH = 11.33$$

- (e) the acidic salt, 0.25 M Al(NO₃)₃

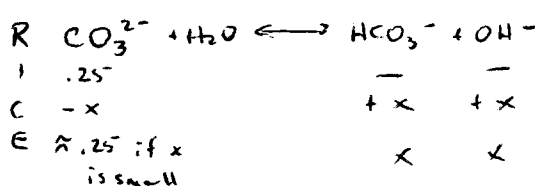


NO_3^- doesn't hydrolyze.

$$K_a = \frac{[Al(H_2O)_5OH^{2+}][H^+]}{[Al(H_2O)_6^{3+}]} = 1.4 \times 10^{-5} = \frac{x^2}{.25}$$

$$x = [H_3O^+] = 1.87 \times 10^{-3} M \quad pH = 2.73$$

- (f) the basic salt, 0.25 M K₂CO₃ K^+ doesn't hydrolyze.



$$K_b = \frac{[HCO_3^-][OH^-]}{[CO_3^{2-}]} = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-11}} = 1.79 \times 10^{-4} = \frac{x^2}{.25}$$

$$[OH^-] = 6.68 \times 10^{-3} M \quad pOH = 2.18 \quad pH = 11.83$$

2. Determine by calculation the relative acidity of

(a) NaHC₂O₄ $K_a = 6.4 \times 10^{-5}$
 $K_b = \frac{1.0 \times 10^{-14}}{5.7 \times 10^{-2}} = 1.7 \times 10^{-13}$ $K_a > K_b$ acidic

(b) NH₄H₂PO₄ $K_a = 5.6 \times 10^{-10}$
 $K_a = 6.2 \times 10^{-8}$
 $K_b = \frac{1.0 \times 10^{-14}}{7.5 \times 10^{-3}} = 1.3 \times 10^{-12}$ $K_a > K_b$ acidic