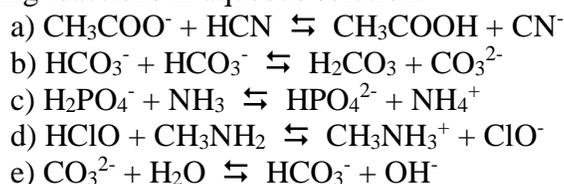


Problems, Chapter 16 (without solutions) NOTE: Unless otherwise stated, assume T = 25. °C in all problems

- 1) What is the Arrhenius definition of an acid? Of a base?
- 2) What is the Bronsted-Lowry definition of an acid? Of a base?
- 3) What is the Lewis definition of an acid? Of a base?
- 4) (16.2) Identify the acid-conjugate base and base-conjugate acid pairs in each of the following reactions in aqueous solution.



- 5) Identify each of the following species as a strong acid, weak acid, strong soluble base, insoluble base, or weak base.

- a) HCN (weak acid)
- b)  $\text{Cu}(\text{OH})_2$  (insoluble base)
- c)  $\text{HNO}_2$  (weak acid)
- d) NaOH (strong soluble base)
- e)  $\text{HClO}_3$  (strong acid)
- f) HClO (weak acid)
- g)  $\text{NH}_3$  (weak base)

- 6) What is meant by the term amphoteric. Show by giving an appropriate set of reactions how the  $\text{HSO}_3^-$  anion exhibits amphoteric properties.

- 7) Complete the table (all solutions are at 25. °C)

$[\text{H}_3\text{O}^+]$	$[\text{OH}^-]$	pH	Acid or base
$3.5 \times 10^{-3}$	_____	_____	_____
_____	$3.8 \times 10^{-7}$	_____	_____
$1.8 \times 10^{-9}$	_____	_____	_____
_____	_____	7.15	base

- 8) The value for the autoionization constant for water at  $T = 40.0 \text{ }^\circ\text{C}$  is  $K_w = 2.92 \times 10^{-14}$ . What are the values for  $[\text{H}_3\text{O}^+]$ ,  $[\text{OH}^-]$ , and pH for a neutral aqueous solution at this temperature?

- 9) (16.26) Find the pH of each of the following solutions:
  - a)  $2.8 \times 10^{-4} \text{ M Ba}(\text{OH})_2$ .
  - b)  $5.2 \times 10^{-4} \text{ M HNO}_3$ .

- 10) How many grams of NaOH would be needed to prepare 500.0 mL of a solution with pH = 12.50?
- 11) (16.52) Find the pH of an aqueous solution at 25. °C that is 0.34 M in phenol ( $C_6H_5OH$ ,  $K_a = 1.3 \times 10^{-10}$ ).
- 12) (16.58) The pH of an aqueous solution of an unknown monoprotic acid is pH = 6.20 at T = 25. °C. The concentration of the acid is 0.010 M. What is  $K_a$  for the acid?
- 13) (16.70) Find the pH for each of the following solutions at T = 25. °C.
- 0.10 M  $NH_3$  ( $K_b = 1.8 \times 10^{-5}$ )
  - 0.050 M pyridine ( $C_5H_5N$ ,  $K_b = 1.7 \times 10^{-9}$ )
- 14) Determine the pH and percent ionization of a 0.220 M solution of benzoic acid ( $C_6H_5COOH$ ,  $K_a = 6.5 \times 10^{-5}$ ).
- 15) The acid dissociation constant for acetic acid ( $CH_3COOH$ ) is  $K_a = 1.8 \times 10^{-5}$  at T = 25. °C.
- What is  $pK_a$  for acetic acid?
  - What is  $K_b$  for the acetate ion,  $CH_3COO^-$ ?
  - Which of the following acids is a stronger acid than acetic acid:  $HNO_2$ ,  $C_6H_5COOH$ ,  $HCN$ ?
  - Which of the following anions is a stronger base than the acetate anion:  $NO_2^-$ ,  $C_6H_5COO^-$ ,  $CN^-$ ?
- 16) (16.10) Predict the relative acid strength of the following compounds:  $H_2O$ ,  $H_2S$ ,  $H_2Se$ .
- 17) Based on molecular structure arrange the binary compounds in order of increasing acid strength. Explain your reasoning.
- $H_2Te$ ,  $HI$ ,  $H_2S$
  - $HClO$ ,  $HClO_2$ ,  $HBrO$
- 18) Determine whether each salt will form a solution that is acidic, basic, or neutral.
- $C_2H_5NH_3NO_3$
  - $K_2CO_3$
  - $RbI$
  - $NH_4ClO$
- 19) (16.96) Find the pH of a 0.082 M solution of NaF ( $K_a$  for HF is  $7.1 \times 10^{-4}$ ).
- 20) Identify the Lewis acid and Lewis base from among the reactants in each equation.
- $Ag^+(aq) + 2 NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq)$
  - $AlBr_3 + NH_3 \rightleftharpoons H_3NAlBr_3$
  - $F^-(aq) + BF_3(aq) \rightleftharpoons BF_4^-(aq)$