


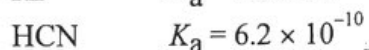
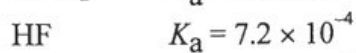
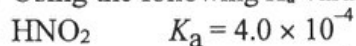
Name: _____ Date: _____

You may use
a calculator.

1. The hydrogen sulfate or bisulfate ion HSO_4^- can act as either an acid or a base in water solution. In which of the following equations does HSO_4^- act as an acid?

- A) $\text{HSO}_4^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + \text{OH}^-$
- B) $\text{HSO}_4^- + \text{H}_3\text{O}^+ \rightarrow \text{SO}_3 + 2\text{H}_2\text{O}$
- C) $\text{HSO}_4^- + \text{OH}^- \rightarrow \text{H}_2\text{SO}_4 + \text{O}^{2-}$
- D) $\text{HSO}_4^- + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + \text{H}_3\text{O}^+$
- E) none of these

2. Using the following K_a values, indicate the correct order of base strength.



- A) $\text{CN}^- > \text{NO}_2^- > \text{F}^- > \text{H}_2\text{O} > \text{Cl}^-$
- B) $\text{Cl}^- > \text{H}_2\text{O} > \text{F}^- > \text{NO}_2^- > \text{CN}^-$
- C) $\text{CN}^- > \text{F}^- > \text{NO}_2^- > \text{Cl}^- > \text{H}_2\text{O}$
- D) $\text{H}_2\text{O} > \text{CN}^- > \text{NO}_2^- > \text{F}^- > \text{Cl}^-$
- E) none of these

3. Calculate the pH of 0.280 M $\text{HNO}_3(\text{aq})$.

- A) 0.553
- B) 2.800
- C) -1.137
- D) 13.720
- E) 13.440

4. Which of the following indicates the most basic solution?

- A) $[\text{H}^+] = 1 \times 10^{-10} \text{ M}$
- B) $\text{pOH} = 6.7$
- C) $[\text{OH}^-] = 7 \times 10^{-5} \text{ M}$
- D) $\text{pH} = 4.2$
- E) At least two of the solutions are equally basic.

5. For nitrous acid, HNO_2 , $K_a = 4.0 \times 10^{-4}$. Calculate the pH of 0.95 M HNO_2 .
- A) 1.71
 - B) 0.02
 - C) 3.42
 - D) 12.29
 - E) none of these
6. Determine the molarity of a solution of the weak acid HClO_2 ($K_a = 1.10 \times 10^{-2}$) if it has a pH of 1.116.
- A) 0.533 M
 - B) 0.0766 M
 - C) 6.96 M
 - D) 12.9 M
 - E) 1.066 M
7. Calculate the pOH of a 0.27 M solution of $\text{Ba}(\text{OH})_2$.
- A) 0.57
 - B) 0.27
 - C) 13.73
 - D) 13.43
 - E) none of these
8. The following question refers to a 0.18 M solution of hypochlorous acid, HClO . The K_a for the acid is 3.5×10^{-8} . Determine the percent dissociation.
- A) $3.5 \times 10^{-6}\%$
 - B) $6.3 \times 10^{-9}\%$
 - C) $7.9 \times 10^{-3}\%$
 - D) $4.4 \times 10^{-2}\%$
 - E) $1.1 \times 10^{-2}\%$
9. Calculate the pH of a 3.8 M solution of aniline ($\text{C}_6\text{H}_5\text{NH}_2$; $K_b = 3.8 \times 10^{-10}$).
- A) 4.42
 - B) 9.58
 - C) 5.16
 - D) 8.84
 - E) none of these

10. The dihydrogenphosphate ion, H_2PO_4^- , has both a conjugate acid and a conjugate base. These are, respectively:
- A) H_3PO_4 , PO_4^{3-}
 - B) H_3PO_4 , HPO_4^{2-}
 - C) H_2PO_4^- , HPO_4^{2-}
 - D) HPO_4^{2-} , PO_4^{3-}
 - E) HPO_4^{2-} , H_3PO_4
11. Which of the following species is present in the greatest concentration in a 0.100 M H_2SO_4 solution in H_2O ?
- A) H_3O^+
 - B) HSO_4^-
 - C) H_2SO_4
 - D) All species are in equilibrium and therefore have the same concentration.
 - E) SO_4^{2-}
12. Which of the following is the correct order for increasing pHs for HNO_3 , KCl , NH_4Cl , KOH , and $\text{NaC}_2\text{H}_3\text{O}_2$? (K_a for $\text{HC}_2\text{H}_3\text{O}_2$ is 1.80×10^{-5} , K_a for NH_4^+ is 5.56×10^{-10}).
- A) KCl , NH_4Cl , HNO_3 , KOH , $\text{NaC}_2\text{H}_3\text{O}_2$
 - B) HNO_3 , KCl , NH_4Cl , KOH , $\text{NaC}_2\text{H}_3\text{O}_2$
 - C) NH_4Cl , HNO_3 , KCl , KOH , $\text{NaC}_2\text{H}_3\text{O}_2$
 - D) HNO_3 , NH_4Cl , KCl , $\text{NaC}_2\text{H}_3\text{O}_2$, KOH
 - E) none of these
13. A 0.50-mol sample of a diprotic acid, H_2A , is dissolved in 250 mL of water. The K_{a1} of this acid is 1.0×10^{-5} and K_{a2} is 1.0×10^{-10} . Calculate the concentration of A^{2-} in this solution.
- A) 1.0×10^{-5} M
 - B) 2.2×10^{-3} M
 - C) 4.5×10^{-3} M
 - D) 1.0×10^{-10} M
 - E) 2.00 M
14. A 0.310-g sample of NaOH(s) is added to enough water to make 250.0 mL of solution. The pH of this solution is:
- A) 1.509
 - B) 0.509
 - C) 11.889
 - D) 12.491
 - E) none of these

15. Calculate the pH of a 0.57 M solution of NH_4Cl . (K_b for $\text{NH}_3 = 1.8 \times 10^{-5}$)
- A) 9.25
 - B) 4.75
 - C) 9.50
 - D) 4.50
 - E) 0.24
16. The hydrogen halides (HF, HCl, HBr, and HI) are all polar molecules. The strength of the acid each forms in water is based on which of the following?
- A) the polarity of the molecule
 - B) the size of the molecule
 - C) the strength of the bond
 - D) two of these
 - E) none of these
17. Which factor listed below is most important in determining the strength of an oxyacid?
- A) the size of the molecule
 - B) the ability of the molecule to change atomic orientation
 - C) the identity of the central atom in the molecule
 - D) the number of oxygen atoms present in the molecule
 - E) none of these
18. The pH of a 1.0 M aqueous solution of NaCl is:
- A) 7.0
 - B) greater than 7.0
 - C) less than 7.0
 - D) not enough information is given
 - E) none of these (a-d)
19. The pH of a 1.0 M sodium acetate solution is:
- A) 7.0
 - B) greater than 7.0
 - C) less than 7.0
 - D) not enough information is given
 - E) none of these (a-d)

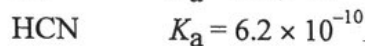
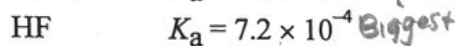
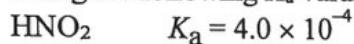
Name: KEY Date: _____

You may use a calculator.

- D 1. The hydrogen sulfate or bisulfate ion HSO_4^- can act as either an acid or a base in water solution. In which of the following equations does HSO_4^- act as an acid?

- A) $\text{HSO}_4^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + \text{OH}^-$
 B) $\text{HSO}_4^- + \text{H}_3\text{O}^+ \rightarrow \text{SO}_3 + 2\text{H}_2\text{O}$
 C) $\text{HSO}_4^- + \text{OH}^- \rightarrow \text{H}_2\text{SO}_4 + \text{O}^{2-}$
 D) $\text{HSO}_4^- + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + \text{H}_3\text{O}^+$
 E) none of these

- A 2. Using the following K_a values, indicate the correct order of base strength.



- A) $\text{CN}^- > \text{NO}_2^- > \text{F}^- > \text{H}_2\text{O} > \text{Cl}^-$
 B) $\text{Cl}^- > \text{H}_2\text{O} > \text{F}^- > \text{NO}_2^- > \text{CN}^-$
 C) $\text{CN}^- > \text{F}^- > \text{NO}_2^- > \text{Cl}^- > \text{H}_2\text{O}$
 D) $\text{H}_2\text{O} > \text{CN}^- > \text{NO}_2^- > \text{F}^- > \text{Cl}^-$
 E) none of these

Base NO_2^-

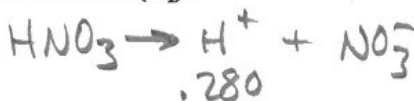
Base F^- - smallest $K_a \rightarrow$ weaker

Base CN^- - biggest $K_b \rightarrow$ strongest

* The Bigger the K_a ,
the smaller the K_b .

- A 3. Calculate the pH of 0.280 M $\text{HNO}_3(\text{aq})$.

- A) 0.553
 B) 2.800
 C) -1.137
 D) 13.720
 E) 13.440



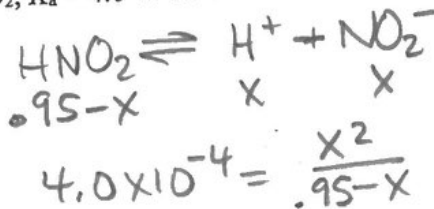
$$-\log .280 = \boxed{.553}$$

- A 4. Which of the following indicates the most basic solution?

- A) $[\text{H}^+] = 1 \times 10^{-10} \text{ M}$
 B) $\text{pOH} = 6.7$
 C) $[\text{OH}^-] = 7 \times 10^{-5} \text{ M}$
 D) $\text{pH} = 4.2$
 E) At least two of the solutions are equally basic.

A 5. For nitrous acid, HNO_2 , $K_a = 4.0 \times 10^{-4}$. Calculate the pH of 0.95 M HNO_2 .

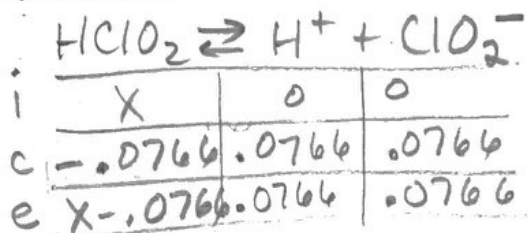
- A) 1.71
- B) 0.02
- C) 3.42
- D) 12.29
- E) none of these



$X = .0195 \text{ M}$
 $\text{pH} = 1.71$

A 6. Determine the molarity of a solution of the weak acid HClO_2 ($K_a = 1.10 \times 10^{-2}$) if it has a pH of 1.116.

- A) 0.533 M
- B) 0.0766 M
- C) 6.96 M
- D) 12.9 M
- E) 1.066 M

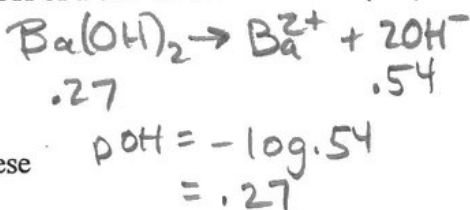


$\text{pH} = 1.116$
 $[\text{H}^+] = 10^{-1.116}$
 $= .0766 \text{ M}$

$$1.10 \times 10^{-2} = \frac{(.0766)^2}{X-.0766}$$

B 7. Calculate the pOH of a 0.27 M solution of $\text{Ba}(\text{OH})_2$.

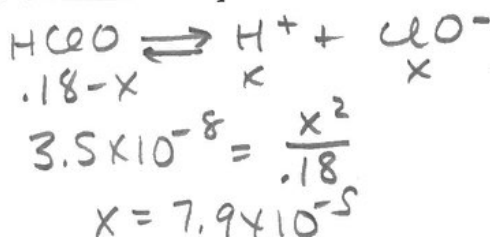
- A) 0.57
- B) 0.27
- C) 13.73
- D) 13.43
- E) none of these



$X = .533 \text{ M}$
 (if use 5% rule)
 $X = .610$ if do not use 5% rule

D 8. The following question refers to a 0.18 M solution of hypochlorous acid, HClO . The K_a for the acid is 3.5×10^{-8} . Determine the percent dissociation.

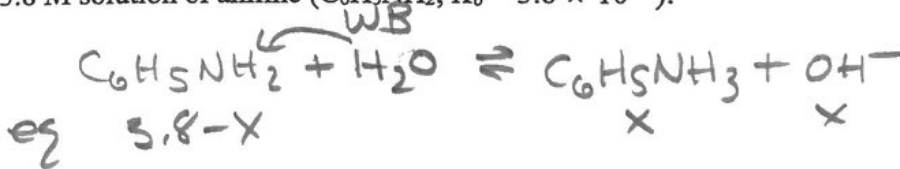
- A) $3.5 \times 10^{-6} \%$
- B) $6.3 \times 10^{-9} \%$
- C) $7.9 \times 10^{-3} \%$
- D) $4.4 \times 10^{-2} \%$
- E) $1.1 \times 10^{-2} \%$



$$\frac{7.9 \times 10^{-5}}{.18} \times 100 = .044 \%$$

B 9. Calculate the pH of a 3.8 M solution of aniline ($\text{C}_6\text{H}_5\text{NH}_2$; $K_b = 3.8 \times 10^{-10}$).

- A) 4.42
- B) 9.58
- C) 5.16
- D) 8.84
- E) none of these



$$3.8 \times 10^{-10} = \frac{X^2}{3.8}$$

$$X = 3.8 \times 10^{-5}$$

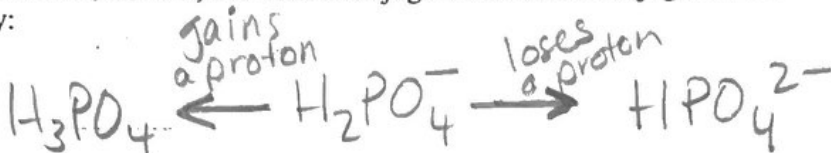
$$\text{pOH} = 4.42$$

$$\text{pH} = 9.58$$

10. The dihydrogenphosphate ion, H_2PO_4^- , has both a conjugate acid and a conjugate base.

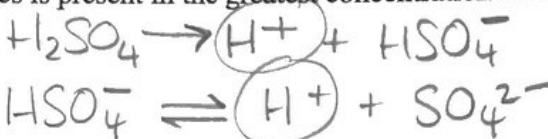
These are, respectively:

- A) $\text{H}_3\text{PO}_4, \text{PO}_4^{3-}$
- B) $\text{H}_3\text{PO}_4, \text{HPO}_4^{2-}$
- C) $\text{H}_2\text{PO}_4^-, \text{HPO}_4^{2-}$
- D) $\text{HPO}_4^{2-}, \text{PO}_4^{3-}$
- E) $\text{HPO}_4^{2-}, \text{H}_3\text{PO}_4$



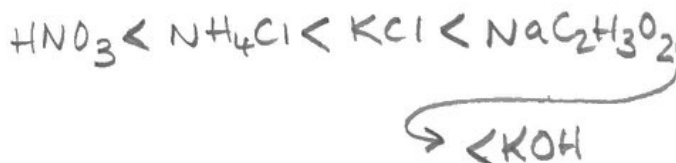
11. Which of the following species is present in the greatest concentration in a 0.100 M H_2SO_4 solution in H_2O ?

- A) H_3O^+
- B) HSO_4^-
- C) H_2SO_4
- D) All species are in equilibrium and therefore have the same concentration.
- E) SO_4^{2-}



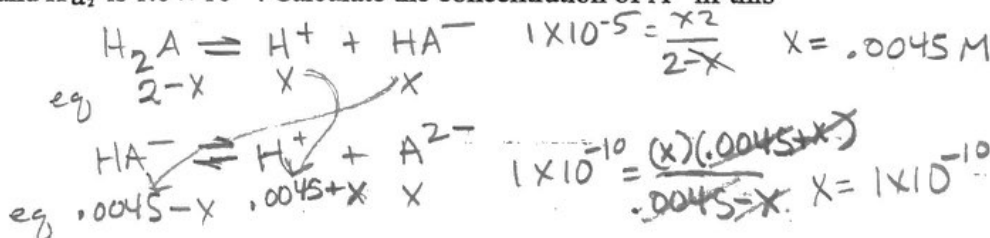
12. Which of the following is the correct order for increasing pHs for $\text{HNO}_3, \text{KCl}, \text{NH}_4\text{Cl}, \text{KOH}$, and $\text{NaC}_2\text{H}_3\text{O}_2$? (K_a for $\text{HC}_2\text{H}_3\text{O}_2$ is 1.80×10^{-5} , K_a for NH_4^+ is 5.56×10^{-10}).

- A) $\text{KCl}, \text{NH}_4\text{Cl}, \text{HNO}_3, \text{KOH}, \text{NaC}_2\text{H}_3\text{O}_2$
- B) $\text{HNO}_3, \text{KCl}, \text{NH}_4\text{Cl}, \text{KOH}, \text{NaC}_2\text{H}_3\text{O}_2$
- C) $\text{NH}_4\text{Cl}, \text{HNO}_3, \text{KCl}, \text{KOH}, \text{NaC}_2\text{H}_3\text{O}_2$
- D) $\text{HNO}_3, \text{NH}_4\text{Cl}, \text{KCl}, \text{NaC}_2\text{H}_3\text{O}_2, \text{KOH}$
- E) none of these



13. A 0.50-mol sample of a diprotic acid, H_2A , is dissolved in 250 mL of water. The K_{a1} of this acid is 1.0×10^{-5} and K_{a2} is 1.0×10^{-10} . Calculate the concentration of A^{2-} in this solution.

- A) $1.0 \times 10^{-5} \text{ M}$
- B) $2.2 \times 10^{-3} \text{ M}$
- C) $4.5 \times 10^{-3} \text{ M}$
- D) $1.0 \times 10^{-10} \text{ M}$
- E) 2.00 M



14. A 0.310-g sample of NaOH(s) is added to enough water to make 250.0 mL of solution. The pH of this solution is:

- A) 1.509
- B) 0.509
- C) 11.889
- D) 12.491
- E) none of these

$\frac{.310 \text{ g NaOH}}{40.00 \text{ g/mol}} = .00775 \text{ mol}$
 $\frac{.00775 \text{ mol}}{.250 \text{ L}} = .0310 \text{ M}$

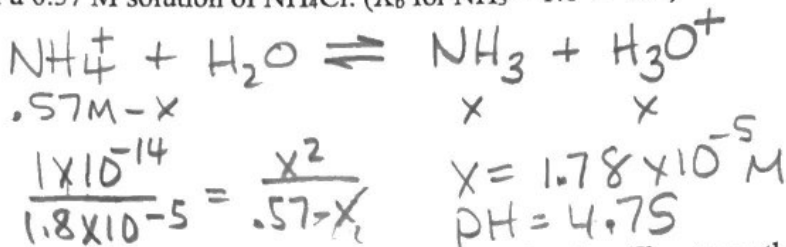
$\text{pOH} = -\log .0310 \quad .1 \rightarrow 1 \left. \begin{array}{l} \text{between} \\ 2 \end{array} \right\}$

$13 \left. \begin{array}{l} \text{between} \\ 12 \end{array} \right\}$

B

15. Calculate the pH of a 0.57 M solution of NH_4Cl . (K_b for $\text{NH}_3 = 1.8 \times 10^{-5}$)

- A) 9.25
- B) 4.75
- C) 9.50
- D) 4.50
- E) 0.24



D

16. The hydrogen halides (HF , HCl , HBr , and HI) are all polar molecules. The strength of the acid each forms in water is based on which of the following?

- A) the polarity of the molecule
- B) the size of the molecule
- C) the strength of the bond
- D) two of these
- E) none of these

D

17. Which factor listed below is most important in determining the strength of an oxyacid?

- A) the size of the molecule
- B) the ability of the molecule to change atomic orientation
- C) the identity of the central atom in the molecule
- D) the number of oxygen atoms present in the molecule
- E) none of these

most important if comparing molecules w/ same # of oxygens

A

18. The pH of a 1.0 M aqueous solution of NaCl is:

- A) 7.0
- B) greater than 7.0
- C) less than 7.0
- D) not enough information is given
- E) none of these (a-d)

\downarrow
NS.

B

19. The pH of a 1.0 M sodium acetate solution is:

- A) 7.0
- B) greater than 7.0
- C) less than 7.0
- D) not enough information is given
- E) none of these (a-d)

\downarrow SCB \rightarrow Basic Salt