10.71 Identify each of the following as an acid, base, or salt, and give its name:
- a. LiOH
- b. $Ca(NO_3)_2$
- c. HBr
- d. $Ba(OH)_2$
- e. H_2CO_3
- f. $HClO_2$

10.72 Identify each of the following as an acid, base, or salt, and give its name:
- a. H_3PO_4
- b. $MgBr_2$
- c. NH_3
- d. H_2SO_4
- e. NaCl
- f. KOH

10.73 Identify the conjugate acid–base pairs in each of the following equations and state whether the equilibrium mixture contains mostly products or mostly reactants:
- a. $NH_{3(aq)} + HNO_{3(aq)} \rightleftharpoons NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$
- b. $H_2O_{(l)} + HBr_{(aq)} \rightleftharpoons H_3O^+{}_{(aq)} + Br^-{}_{(aq)}$

10.74 Identify the conjugate acid–base pairs in each of the following equations and state whether the equilibrium mixture contains mostly products or mostly reactants:
- a. $HNO_{2(aq)} + HS^-{}_{(aq)} \rightleftharpoons H_2S_{(g)} + NO_2^-{}_{(aq)}$
- b. $Cl^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons OH^-{}_{(aq)} + HCl_{(aq)}$

10.75 Complete the following table:

Acid	Conjugate Base
HI	
	Cl^-
NH_4^+	
	HS^-

10.76 Complete the following table:

Base	Conjugate Acid
	HS^-
	$HC_2H_3O_2$
NH_3	
ClO_4^-	

10.77 Are each of the following solutions acidic, basic, or neutral?
- a. rain, pH 5.2
- b. tears, pH 7.5
- c. tea, pH 3.8
- d. cola, pH 2.5
- e. photo developer, pH 12.0

10.78 Are each of the following solutions acidic, basic, or neutral?
- a. saliva, pH 6.8
- b. urine, pH 5.9
- c. pancreatic juice, pH 8.0
- d. bile, pH 8.4
- e. blood, pH 7.45

10.79 Using Table 10.3, identify the stronger acid in each of the following pairs:
- a. HF or H2S
- b. H_3O^+ or H_2CO_3
- c. HNO_2 or $HC_2H_3O_2$
- d. H_2O or HCO_3^-

10.80 Using Table 10.3, identify the stronger base in each of the following pairs:
- a. H_2O or Cl-
- b. OH^- or H_2CO_3
- c. SO_4^{2-} or NO_2^-
- d. CO_3^{2-} or H_2O

10.81 Determine the pH for the following solutions:
- a. $[H_3O^+] = 2.0 \times 10^{-8}$ M
- b. $[H_3O^+] = 5.0 \times 10^{-2}$ M
- c. $[OH^-] = 3.5 \times 10^{-4}$ M
- d. $[OH^-] = 0.0054$ M

10.82 Determine the pH for the following solutions:
- a. $[OH^-] = 1.0 \times 10^{-7}$ M
- b. $[H_3O^+] = 4.2 \times 10^{-3}$ M
- c. $[H_3O^+] = 0.0001$ M
- d. $[OH^-] = 8.5 \times 10^{-9}$ M

10.83 Are the solutions in Problem 10.81 acidic, basic, or neutral?
- a. $[H_3O^+] = 2.0 \times 10^{-8}$ M
- b. $[H_3O^+] = 5.0 \times 10^{-2}$ M
- c. $[OH^-] = 3.5 \times 10^{-4}$ M
- d. $[OH^-] = 0.0054$ M

10.84 Are the solutions in Problem 10.82 acidic, basic, or neutral?
- a. $[OH^-] = 1.0 \times 10^{-7}$ M
- b. $[H_3O^+] = 4.2 \times 10^{-3}$ M
- c. $[H_3O^+] = 0.0001$ M
- d. $[OH^-] = 8.5 \times 10^{-9}$ M

10.85 What are the $[H_3O^+]$ and $[OH^-]$ for a solution with each of the following pH values?
- a. 3.00
- b. 6.48
- c. 8.85
- d. 11.00

10.86 What are the $[H_3O^+]$ and $[OH^-]$ for a solution with each of the following pH values?
- a. 10.0
- b. 5.0
- c. 7.00
- d. 1.82

10.87 Sour milk (A) has a pH of 4.5, and maple syrup (B) has a pH of 6.7.
- a. Which solution is more acidic?
- b. What is the $[H_3O^+]$ in each?
- c. What is the $[OH^-]$ in each?

10.88 A solution of borax (A) has a pH of 9.2, and human saliva (B) has a pH of 6.5.
- a. Which solution is more acidic?
- b. What is the $[H_3O^+]$ in each?
- c. What is the $[OH^-]$ in each?

10.89 What is the $[OH^-]$ in a solution that contains 0.225 g of NaOH in 0.250 L of solution?

10.90 What is the $[H_3O^+]$ in a solution that contains 1.54 g of HNO_3 in 0.500 L of solution?

10.91 What is the pH of a solution prepared by dissolving 2.5 g of HCl in water to make 425 mL of solution?

10.92 What is the pH of a solution prepared by dissolving 1.00 g of $Ca(OH)_2$ in water to make 875 mL of solution?

10.93 a. Write the neutralization equation for KOH and H_3PO_4.
b. Calculate the volume (mL) of a 0.150 M KOH solution that will completely neutralize 10.0 mL of a 0.560 M H_3PO_4 solution.

10.94 a. Write the neutralization equation for NaOH and H_2SO_4.
b. How many milliliters of a 0.215 M NaOH solution are needed to completely neutralize 2.50 mL of a 0.825 M H_2SO_4 solution?

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Answers…

10.71 Identify each of the following as an acid, base, or salt, and give its name:

a. $LiOH$ ..... Base .....Lithium Hydroxide
b. $Ca(NO_3)_2$ ..... Salt .....Calcium Nitrate
c. HBr ..... Acid .....Hydrobromic Acid
d. $Ba(OH)_2$ ..... Base .....Barium Hydroxide
e. H_2CO_3 ..... Acid .....Carbonic Acid
f. $HClO_2$ ..... Acid .....Chlorous Acid

10.72 Identify each of the following as an acid, base, or salt, and give its name:

a. H_3PO_4 ..... Acid .....Phosphoric Acid
b. $MgBr_2$ ..... Salt .....Magnesium Bromide
c. NH_3 ..... Base .....Ammonium Hydroxide
d. H_2SO_4 ..... Acid .....Sulfuric Acid
e. $NaCl$ ..... Salt .....Sodium Chloride
f. KOH ..... Base .....Potassium Hydroxide

10.73 Identify the conjugate acid–base pairs in each of the following equations and state whether the equilibrium mixture contains mostly products or mostly reactants:

a. $NH_{3(aq)} + HNO_{3(aq)} \rightleftharpoons NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}$
- Acid .....HNO_3
- Base .....NH_4OH
- Conjugate Acid .....NH_4^+
- Conjugate Base .....NO_3^-
- Mostly Products (HNO_3 is a strong acid)

b. $H_2O_{(l)} + HBr_{(aq)} \rightleftharpoons H_3O^+{}_{(aq)} + Br^-{}_{(aq)}$
- Acid .....HBr
- Base .....H_2O
- Conjugate Acid .....H_3O^+
- Conjugate Base .....Br^-
- Mostly Products (HBr is a strong acid)

10.74 Identify the conjugate acid–base pairs in each of the following equations and state whether the equilibrium mixture contains mostly products or mostly reactants:

a. $HNO_{2(aq)} + HS^-{}_{(aq)} \rightleftharpoons H_2S_{(g)} + NO_2^-{}_{(aq)}$
- Acid .....HNO_2
- Base .....HS^-
- Conjugate Acid .....H_2S
- Conjugate Base .....NO_2^-
- Mostly Reactants (No strong acid or base)

b. $Cl^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons OH^-{}_{(aq)} + HCl_{(aq)}$
- Acid .....H_2O
- Base .....Cl^-
- Conjugate Acid .....HCl
- Conjugate Base .....OH^-
- Mostly Reactants (HCl is a strong acid)

10.75 Complete the following table:

Acid	Conjugate Base
HI	I^-
HCl	Cl^-
NH_4^+	NH_3
H_2S	HS^-

10.76 Complete the following table:

Base	Conjugate Acid
S^{2-}	HS^-
$C_2H_3O_2^-$	$HC_2H_3O_2$
NH_3	NH_4^+
ClO_4^-	$HClO_4$

10.77 Are each of the following solutions acidic, basic, or neutral?

a. rain, pH 5.2 ..... Acidic
b. tears, pH 7.5 ..... Basic
c. tea, pH 3.8 ..... Acidic
d. cola, pH 2.5..... Acidic
e. photo developer, pH 12.0..... Basic

10.78 Are each of the following solutions acidic, basic, or neutral?

a. saliva, pH 6.8 ..... Acidic
b. urine, pH 5.9 ..... Acidic
c. pancreatic juice, pH 8.0 ..... Basic
d. bile, pH 8.4..... Basic
e. blood, pH 7.45 ..... Basic

TABLE 10.3 Some Conjugate Acid–Base Pairs

Increasing Acid Strength

Acid		Conjugate Base	
Strong Acids			
Hydroiodic acid	HI	I^-	Iodide ion
Hydrobromic acid	HBr	Br^-	Bromide ion
Perchloric acid	$HClO_4$	ClO_4^-	Perchlorate ion
Hydrochloric acid	HCl	Cl^-	Chloride ion
Sulfuric acid	H_2SO_4	HSO_4^-	Hydrogen sulfate ion
Nitric acid	HNO_3	NO_3^-	Nitrate ion
Weak Acids			
Hydronium ion	H_3O^+	H_2O	Water
Hydrogen sulfate ion	HSO_4^-	SO_4^{2-}	Sulfate ion
Phosphoric acid	H_3PO_4	$H_2PO_4^-$	Dihydrogen phosphate ion
Hydrofluoric acid	HF	F^-	Fluoride ion
Nitrous acid	HNO_2	NO_2^-	Nitrite ion
Acetic acid	$HC_2H_3O_2$	$C_2H_3O_2^-$	Acetate ion
Carbonic acid	H_2CO_3	HCO_3^-	Bicarbonate ion
Hydrosulfuric acid	H_2S	HS^-	Hydrogen sulfide ion
Dihydrogen phosphate ion	$H_2PO_4^-$	HPO_4^{2-}	Hydrogen phosphate ion
Ammonium ion	NH_4^+	NH_3	Ammonia
Bicarbonate ion	HCO_3^-	CO_3^{2-}	Carbonate ion
Hydrogen sulfide ion	HS^-	S^{2-}	Sulfide ion
Water	H_2O	OH^-	Hydroxide ion

Increasing Base Strength

10.79 Using Table 10.3, identify the stronger acid in each of the following pairs:

a. HF or H_2S ..... HF
b. H_3O^+ or H_2CO_3..... H_3O^+
c. HNO_2 or $HC_2H_3O_2$..... HNO_2
d. H_2O or HCO_3^-..... HCO_3^-

10.80 Using Table 10.3, identify the stronger base in each of the following pairs:

a. H_2O or Cl^-..... H_2O
b. OH^- or H_2CO_3..... OH^-
c. SO_4^{2-} or NO_2^- ..... NO_2^-
d. CO_3^{2-} or H_2O ..... CO_3^{2-}

10.81 Determine the pH for the following solutions:

a. $[H_3O^+] = 2.0 \times 10^{-8}$ M..... $-\log(2.0 \times 10^{-8})$ ..... pH = 7.70
b. $[H_3O^+] = 5.0 \times 10^{-2}$ M..... $-\log(5.0 \times 10^{-2})$ ..... pH = 1.30
c. $[OH^-] = 3.5 \times 10^{-4}$ M..... $-\log(3.5 \times 10^{-4})$ ..... pOH = 3.46..... pH = 10.54
d. $[OH^-] = 0.0054$ M..... $-\log(0.0054)$ ..... pOH = 2.27..... pH = 11.73

10.82 Determine the pH for the following solutions:

a. $[OH^-] = 1.0 \times 10^{-7}$ M..... $-\log(1.0 \times 10^{-7})$ ..... pOH = 7.00..... pH = 7.00
b. $[H_3O^+] = 4.2 \times 10^{-3}$ M..... $-\log(4.2 \times 10^{-3})$ ..... pH = 2.38
c. $[H_3O^+] = 0.0001$ M..... $-\log(0.0001)$ ..... pH = 4.0
d. $[OH^-] = 8.5 \times 10^{-9}$ M..... $-\log(8.5 \times 10^{-9})$ ..... pOH = 8.07..... pH = 5.93

10.83 Are the solutions in Problem 10.81 acidic, basic, or neutral?

a. $[H_3O^+]$ = 2.0 x 10^{-8} M..... pH = 7.70 ..... Basic
b. $[H_3O^+]$ = 5.0 x 10^{-2} M..... pH = 1.30 ..... Acidic
c. $[OH^-]$ = 3.5 x 10^{-4} M..... pH = 10.84 ..... Basic
d. $[OH^-]$ = 0.0054 M..... pH = 11.73 ..... Basic

10.84 Are the solutions in Problem 10.82 acidic, basic, or neutral?

a. $[OH^-]$ = 1.0 x 10^{-7} M..... pH = 7.00 ..... Neutral
b. $[H_3O^+]$ = 4.2 x 10^{-3} M..... pH = 2.38 ..... Acidic
c. $[H_3O^+]$ = 0.0001 M..... pH = 4.0 ..... Acidic
d. $[OH^-]$ = 8.5 x 10^{-9} M..... pH = 8.07 ..... Basic

10.85 What are the $[H_3O^+]$ and $[OH^-]$ for a solution with each of the following pH values?

a. 3.00.....10^(-3.00) ..... $[H_3O^+]$ = 1.0 x 10^{-3}M..... $[OH^-]$ = 1.0 x 10^{-11}M
b. 6.48.....10^(-6.48) ..... $[H_3O^+]$ = 3.3 x 10^{-7}M..... $[OH^-]$ = 3.0 x 10^{-8}M
c. 8.85.....10^(-8.85) ..... $[H_3O^+]$ = 1.4 x 10^{-9}M..... $[OH^-]$ = 7.1 x 10^{-6}M
d. 11.00.....10^(-11.00) ..... $[H_3O^+]$ = 1.0 x 10^{-11}M..... $[OH^-]$ = 1.0 x 10^{-3}M

10.86 What are the $[H_3O^+]$ and $[OH^-]$ for a solution with each of the following pH values?

a. 10.0.....10^(-10.0) ..... $[H_3O^+]$ = 1.0 x 10^{-10}M..... $[OH^-]$ = 1.0 x 10^{-4}M
b. 5.0.....10^(-5.0) ..... $[H_3O^+]$ = 1 x 10^{-5}M..... $[OH^-]$ = 1 x 10^{-9}M
c. 7.00.....10^(-7.00) ..... $[H_3O^+]$ = 1.0 x 10^{-7}M..... $[OH^-]$ = 1.0 x 10^{-7}M
d. 1.82.....10^(-1.82) ..... $[H_3O^+]$ = 1.5 x 10^{-2}M..... $[OH^-]$ = 6.7 x 10^{-13}M

10.87 Sour milk (A) has a pH of 4.5, and maple syrup (B) has a pH of 6.7.

a. Which solution is more acidic?.....Sour Milk
b. What is the $[H_3O^+]$ in each?
   - Sour Milk ..... $[H_3O^+]$ = 10^(-4.5) ..... $[H_3O^+]$ = 3 x 10^{-5}M
   - Maple Syrup ..... $[H_3O^+]$ = 10^(-6.7) ..... $[H_3O^+]$ = 2 x 10^{-7}M
c. What is the $[OH^-]$ in each?
   - Sour Milk .....pOH = 14-4.5 = 9.5..... $[OH^-]$ = 10^(-9.5) .....$[OH^-]$ = 3 x 10^{-10}M
   - Maple Syrup ....pOH = 14-6.7 = 7.3..... $[OH^-]$ = 10^(-7.3) .....$[OH^-]$ = 5 x 10^{-8}M

10.88 A solution of borax (A) has a pH of 9.2, and human saliva (B) has a pH of 6.5.

a. Which solution is more acidic?.....Human Saliva
b. What is the $[H_3O^+]$ in each?
   a. Borax..... $[H_3O^+]$ = 10^(-9.2) ..... $[H_3O^+]$ = 6 x 10^{-10}M
   b. Saliva..... $[H_3O^+]$ = 10^(-6.5) ..... $[H_3O^+]$ = 3 x 10^{-7}M
c. What is the $[OH^-]$ in each?
   a. Borax.....pOH = 14-9.2 = 4.8..... $[OH^-]$ = 10^(-4.8) .....$[OH^-]$ = 2 x 10^{-5}M
   b. Saliva.....pOH = 14-6.5 = 7.5..... $[OH^-]$ = 10^(-7.5) .....$[OH^-]$ = 3 x 10^{-8}M

10.89 What is the $[OH^-]$ in a solution that contains 0.225 g of NaOH in 0.250 L of solution?

$$[NaOH] = \frac{Moles\ NaOH}{Liters\ of\ Solution} = \frac{0.225\ g\ NaOH}{0.250\ L\ of\ NaOH\ solution} * \frac{1\ Mole\ NaOH}{40.0 g\ NaOH} = 0.0225\ M\ NaOH$$

$$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

Since NaOH is a strong base it completely dissociates, [NaOH] = $[OH^-]$ = 0.0225 M NaOH

10.90 What is the $[H_3O^+]$ in a solution that contains 1.54 g of HNO_3 in 0.500 L of solution?

$$[HNO_3] = \frac{Moles\ HNO_3}{Liters\ of\ Solution} = \frac{1.54\ g\ HNO_3}{0.500\ L\ of HNO_3\ solution} * \frac{1\ Mole\ HNO_3}{63.0 g\ HNO_3} = 0.0489\ M\ HNO_3$$

$$HNO_{3(aq)} \rightarrow H^+_{(aq)} + NO^-_{3(aq)}$$

Since HNO_3 is a strong acid it completely dissociates, $[HNO_3]$ = $[H_3O^+]$ = 0.0489 M HNO_3

10.91 What is the pH of a solution prepared by dissolving 2.5 g of HCl in water to make 425 mL of solution?

$$[HCl] = \frac{Moles\ HCl}{Liters\ of\ Solution} = \frac{2.5\ g\ HCl}{0.425\ L\ of\ HCl\ solution} * \frac{1\ Mole\ HCl}{36.5\ g\ HCl} = 0.16\ M\ HCl$$

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

Since HCl is a strong acid it completely dissociates, [HCl] = $[H_3O^+]$ = 0.16 M

$$pH = -\log([H_3O^+]) = -\log(0.16)\ or\ pH = 0.80$$

10.92 What is the pH of a solution prepared by dissolving 1.00 g of $Ca(OH)_2$ in water to make 875 mL of solution?

$$[Ca(OH)_2] = \frac{Moles\ Ca(OH)_2}{Liters\ of\ Solution} = \frac{1.00\ g\ Ca(OH)_2}{0.875\ L\ of\ Ca(OH)_2\ solution} * \frac{1\ Mole\ Ca(OH)_2}{74.1\ g\ Ca(OH)_2} = 0.0154\ M\ Ca(OH)_2$$

$$Ca(OH)_{2(aq)} \rightarrow Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$$

Since $Ca(OH)_2$ is a strong base it completely dissociates, 2* $[Ca(OH)_2]$ = $[OH^-]$ = 0.0308 M

(note that the [OH-] is twice that of the $Ca(OH)_2$)

$$pOH = -\log([OH^-]) = -\log(0.0308)\ or\ pOH = 1.511$$

$$pH = 14 - pOH = 14 - 1.511 = 12.489$$

10.93 a. Write the neutralization equation for KOH and H_3PO_4.

$$3KOH_{(aq)} + H_3PO_{4(aq)} \rightarrow 3H_2O_{(l)} + K_3PO_{4(aq)}$$

b. Calculate the volume (mL) of a 0.150 M KOH solution that will completely neutralize 10.0 mL of a 0.560 M H_3PO_4 solution.

$$3\ moles\ KOH_{(aq)} = 1\ mole\ H_3PO_{4(aq)}$$

Determined by using the balanced equation

$$\frac{0.560\ moles\ H_3PO_4}{liters\ of\ H_3PO_4\ solution} * 0.01000\ L\ H_3PO_4 * \frac{3\ moles\ KOH}{1\ mole\ H_3PO_4} * \frac{1\ liter\ of\ KOH}{0.150\ m\ KOH} = 0.112\ L\ KOH$$

112 ml KOH

10.94 a. Write the neutralization equation for NaOH and H_2SO_4.

$$H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow 2H_2O_{(l)} + Na_2SO_{4(aq)}$$

b. How many milliliters of a 0.215 M NaOH solution are needed to completely neutralize 2.50 mL of a 0.825 M H_2SO_4 solution?

$$2\ moles\ NaOH_{(aq)} = 1\ mole\ H_2SO_{4(aq)}$$

Determined by using the balanced equation

$$\frac{0.825\ moles\ H_2SO_4}{liters\ of\ H_2SO_4\ solution} * 0.00250\ L\ H_2SO_4 * \frac{2\ moles\ NaOH}{1\ mole\ H_2SO_4} * \frac{1\ liter\ of\ NaOH}{0.215\ m\ NaOH} = 0.0191\ L\ NaOH$$

1.91 ml NaOH