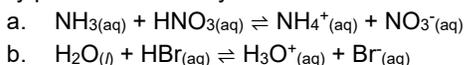


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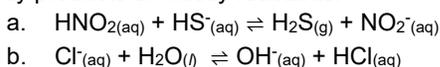
- 10.71 Identify each of the following as an acid, base, or salt, and give its name:
- LiOH
 - $\text{Ca}(\text{NO}_3)_2$
 - HBr
 - $\text{Ba}(\text{OH})_2$
 - H_2CO_3
 - HClO_2

- 10.72 Identify each of the following as an acid, base, or salt, and give its name:
- H_3PO_4
 - MgBr_2
 - NH_3
 - H_2SO_4
 - NaCl
 - 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:



- 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:



- 10.75 Complete the following table:

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

- 10.76 Complete the following table:

Base	Conjugate Acid
	HS^-
	$\text{HC}_2\text{H}_3\text{O}_2$
NH_3	
ClO_4^-	

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

- rain, pH 5.2
- tears, pH 7.5
- tea, pH 3.8
- cola, pH 2.5
- photo developer, pH 12.0

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

- saliva, pH 6.8
- urine, pH 5.9
- pancreatic juice, pH 8.0
- bile, pH 8.4
- blood, pH 7.45

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

- HF or H_2S
- H_3O^+ or H_2CO_3
- HNO_2 or $\text{HC}_2\text{H}_3\text{O}_2$
- H_2O or HCO_3^-

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

- H_2O or Cl^-
- OH^- or H_2CO_3
- SO_4^{2-} or NO_2^-
- CO_3^{2-} or H_2O

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- 10.81 Determine the pH for the following solutions:
- $[\text{H}_3\text{O}^+] = 2.0 \times 10^{-8} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 5.0 \times 10^{-2} \text{ M}$
 - $[\text{OH}^-] = 3.5 \times 10^{-4} \text{ M}$
 - $[\text{OH}^-] = 0.0054 \text{ M}$
- 10.82 Determine the pH for the following solutions:
- $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 4.2 \times 10^{-3} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 0.0001 \text{ M}$
 - $[\text{OH}^-] = 8.5 \times 10^{-9} \text{ M}$
- 10.83 Are the solutions in Problem 10.81 acidic, basic, or neutral?
- $[\text{H}_3\text{O}^+] = 2.0 \times 10^{-8} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 5.0 \times 10^{-2} \text{ M}$
 - $[\text{OH}^-] = 3.5 \times 10^{-4} \text{ M}$
 - $[\text{OH}^-] = 0.0054 \text{ M}$
- 10.84 Are the solutions in Problem 10.82 acidic, basic, or neutral?
- $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 4.2 \times 10^{-3} \text{ M}$
 - $[\text{H}_3\text{O}^+] = 0.0001 \text{ M}$
 - $[\text{OH}^-] = 8.5 \times 10^{-9} \text{ M}$
- 10.85 What are the $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ for a solution with each of the following pH values?
- 3.00
 - 6.48
 - 8.85
 - 11.00
- 10.86 What are the $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ for a solution with each of the following pH values?
- 10.0
 - 5.0
 - 7.00
 - 1.82
- 10.87 Sour milk (A) has a pH of 4.5, and maple syrup (B) has a pH of 6.7.
- Which solution is more acidic?
 - What is the $[\text{H}_3\text{O}^+]$ in each?
 - What is the $[\text{OH}^-]$ 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.
- Which solution is more acidic?
 - What is the $[\text{H}_3\text{O}^+]$ in each?
 - What is the $[\text{OH}^-]$ in each?
- 10.89 What is the $[\text{OH}^-]$ in a solution that contains 0.225 g of NaOH in 0.250 L of solution?
- 10.90 What is the $[\text{H}_3\text{O}^+]$ 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 $\text{Ca}(\text{OH})_2$ in water to make 875 mL of solution?
- 10.93
- Write the neutralization equation for KOH and H_3PO_4 .
 - 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
- Write the neutralization equation for NaOH and H_2SO_4 .
 - 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:

- LiOH..... Base.....Lithium Hydroxide
- Ca(NO₃)₂..... Salt.....Calcium Nitrate
- HBr..... Acid.....Hydrobromic Acid
- Ba(OH)₂..... Base.....Barium Hydroxide
- H₂CO₃..... Acid.....Carbonic Acid
- HClO₂..... Acid.....Chlorous Acid

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

- H₃PO₄..... Acid.....Phosphoric Acid
- MgBr₂..... Salt.....Magnesium Bromide
- NH₃..... Base.....Ammonium Hydroxide
- H₂SO₄..... Acid.....Sulfuric Acid
- NaCl..... Salt.....Sodium Chloride
- 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:

- $$\text{NH}_3(\text{aq}) + \text{HNO}_3(\text{aq}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$$
 - AcidHNO₃
 - BaseNH₄OH
 - Conjugate AcidNH₄⁺
 - Conjugate BaseNO₃⁻
 - Mostly Products (HNO₃ is a strong acid)
- $$\text{H}_2\text{O}(\text{l}) + \text{HBr}(\text{aq}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{Br}^-(\text{aq})$$
 - AcidHBr
 - BaseH₂O
 - Conjugate AcidH₃O⁺
 - Conjugate BaseBr⁻
 - 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:

- $$\text{HNO}_2(\text{aq}) + \text{HS}^-(\text{aq}) \rightleftharpoons \text{H}_2\text{S}(\text{g}) + \text{NO}_2^-(\text{aq})$$
 - AcidHNO₂
 - BaseHS⁻
 - Conjugate AcidH₂S
 - Conjugate BaseNO₂⁻
 - Mostly Reactants (No strong acid or base)
- $$\text{Cl}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{OH}^-(\text{aq}) + \text{HCl}(\text{aq})$$
 - AcidH₂O
 - BaseCl⁻
 - Conjugate AcidHCl
 - Conjugate BaseOH⁻
 - 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 ₂ S	HS ⁻

10.76 Complete the following table:

Base	Conjugate Acid
S ²⁻	HS ⁻
C ₂ H ₃ O ₂ ⁻	HC ₂ H ₃ O ₂
NH ₃	NH ₄ ⁺
ClO ₄ ⁻	HClO ₄

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

- rain, pH 5.2 **Acidic**
- tears, pH 7.5 **Basic**
- tea, pH 3.8 **Acidic**
- cola, pH 2.5 **Acidic**
- photo developer, pH 12.0 **Basic**

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

- saliva, pH 6.8 **Acidic**
- urine, pH 5.9 **Acidic**
- pancreatic juice, pH 8.0 **Basic**
- bile, pH 8.4 **Basic**
- blood, pH 7.45 **Basic**

TABLE 10.3 Some Conjugate Acid–Base Pairs

Acid	Conjugate Base		
	Chemical Formula	Chemical Formula	Name
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 ₂ SO ₄	HSO ₄ ⁻	Hydrogen sulfate ion
Nitric acid	HNO ₃	NO ₃ ⁻	Nitrate ion
Weak Acids			
Hydronium ion	H ₃ O ⁺	H ₂ O	Water
Hydrogen sulfate ion	HSO ₄ ⁻	SO ₄ ²⁻	Sulfate ion
Phosphoric acid	H ₃ PO ₄	H ₂ PO ₄ ⁻	Dihydrogen phosphate ion
Hydrofluoric acid	HF	F ⁻	Fluoride ion
Nitrous acid	HNO ₂	NO ₂ ⁻	Nitrite ion
Acetic acid	HC ₂ H ₃ O ₂	C ₂ H ₃ O ₂ ⁻	Acetate ion
Carbonic acid	H ₂ CO ₃	HCO ₃ ⁻	Bicarbonate ion
Hydrosulfuric acid	H ₂ S	HS ⁻	Hydrogen sulfide ion
Dihydrogen phosphate ion	H ₂ PO 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 ₂ O	OH ⁻	Hydroxide ion

Note: The table is flanked by a red arrow pointing up labeled 'Increasing Acid Strength' and a blue arrow pointing down labeled 'Increasing Base Strength'.

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

- HF or H₂S **HF**
- H₃O⁺ or H₂CO₃ **H₃O⁺**
- HNO₂ or HC₂H₃O₂ **HNO₂**
- H₂O or HCO₃⁻ **HCO₃⁻**

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

- H₂O or Cl⁻ **H₂O**
- OH⁻ or H₂CO₃ **OH⁻**
- SO₄²⁻ or NO₂⁻ **NO₂⁻**
- CO₃²⁻ or H₂O **CO₃²⁻**

10.81 Determine the pH for the following solutions:

- [H₃O⁺] = 2.0 × 10⁻⁸ M -log(2.0 × 10⁻⁸) **pH = 7.70**
- [H₃O⁺] = 5.0 × 10⁻² M -log(5.0 × 10⁻²) **pH = 1.30**
- [OH⁻] = 3.5 × 10⁻⁴ M -log(3.5 × 10⁻⁴) **pOH = 3.46 pH = 10.54**
- [OH⁻] = 0.0054 M -log(0.0054) **pOH = 2.27 pH = 11.73**

10.82 Determine the pH for the following solutions:

- [OH⁻] = 1.0 × 10⁻⁷ M -log(1.0 × 10⁻⁷) **pOH = 7.00 pH = 7.00**
- [H₃O⁺] = 4.2 × 10⁻³ M -log(4.2 × 10⁻³) **pH = 2.38**
- [H₃O⁺] = 0.0001 M -log(0.0001) **pH = 4.0**
- [OH⁻] = 8.5 × 10⁻⁹ M -log(8.5 × 10⁻⁹) **pOH = 8.07 pH = 5.93**

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

- $[H_3O^+] = 2.0 \times 10^{-8} M$ pH = 7.70 Basic
- $[H_3O^+] = 5.0 \times 10^{-2} M$ pH = 1.30 Acidic
- $[OH^-] = 3.5 \times 10^{-4} M$ pH = 10.84 Basic
- $[OH^-] = 0.0054 M$ pH = 11.73 Basic

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

- $[OH^-] = 1.0 \times 10^{-7} M$ pH = 7.00 Neutral
- $[H_3O^+] = 4.2 \times 10^{-3} M$ pH = 2.38 Acidic
- $[H_3O^+] = 0.0001 M$ pH = 4.0 Acidic
- $[OH^-] = 8.5 \times 10^{-9} M$ pH = 8.07 Basic

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

- 3.00 $10^{-(3.00)}$ $[H_3O^+] = 1.0 \times 10^{-3} M$ $[OH^-] = 1.0 \times 10^{-11} M$
- 6.48 $10^{-(6.48)}$ $[H_3O^+] = 3.3 \times 10^{-7} M$ $[OH^-] = 3.0 \times 10^{-8} M$
- 8.85 $10^{-(8.85)}$ $[H_3O^+] = 1.4 \times 10^{-9} M$ $[OH^-] = 7.1 \times 10^{-6} M$
- 11.00 $10^{-(11.00)}$ $[H_3O^+] = 1.0 \times 10^{-11} M$ $[OH^-] = 1.0 \times 10^{-3} M$

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

- 10.0 $10^{-(10.0)}$ $[H_3O^+] = 1.0 \times 10^{-10} M$ $[OH^-] = 1.0 \times 10^{-4} M$
- 5.0 $10^{-(5.0)}$ $[H_3O^+] = 1 \times 10^{-5} M$ $[OH^-] = 1 \times 10^{-9} M$
- 7.00 $10^{-(7.00)}$ $[H_3O^+] = 1.0 \times 10^{-7} M$ $[OH^-] = 1.0 \times 10^{-7} M$
- 1.82 $10^{-(1.82)}$ $[H_3O^+] = 1.5 \times 10^{-2} M$ $[OH^-] = 6.7 \times 10^{-13} M$

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

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

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

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

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

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

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

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

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

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

$$HNO_{3(aq)} \rightarrow H^+_{(aq)} + NO_{3(aq)}^-$$

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

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?

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

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

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

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

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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?

$$[\text{Ca(OH)}_2] = \frac{\text{Moles Ca(OH)}_2}{\text{Liters of Solution}} = \frac{1.00 \text{ g Ca(OH)}_2}{0.875 \text{ L of Ca(OH)}_2 \text{ solution}} * \frac{1 \text{ Mole Ca(OH)}_2}{74.1 \text{ g Ca(OH)}_2} = 0.0154 \text{ M Ca(OH)}_2$$
$$\text{Ca(OH)}_2(\text{aq}) \rightarrow \text{Ca}^{2+}_{(\text{aq})} + 2\text{OH}^{-}_{(\text{aq})}$$

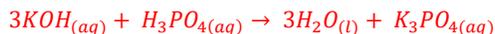
Since Ca(OH)_2 is a strong base it completely dissociates, $2 * [\text{Ca(OH)}_2] = [\text{OH}^-] = 0.0308 \text{ M}$

(note that the $[\text{OH}^-]$ is twice that of the Ca(OH)_2)

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

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

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



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.

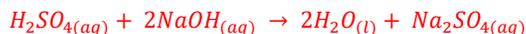
$$3 \text{ moles KOH}_{(\text{aq})} = 1 \text{ mole H}_3\text{PO}_{4(\text{aq})}$$

Determined by using the balanced equation

$$\frac{0.560 \text{ moles H}_3\text{PO}_4}{\text{liters of H}_3\text{PO}_4 \text{ solution}} * 0.01000 \text{ L H}_3\text{PO}_4 * \frac{3 \text{ moles KOH}}{1 \text{ mole H}_3\text{PO}_4} * \frac{1 \text{ liter of KOH}}{0.150 \text{ m KOH}} = 0.112 \text{ L KOH}$$

112 ml KOH

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?

$$2 \text{ moles NaOH}_{(\text{aq})} = 1 \text{ mole H}_2\text{SO}_{4(\text{aq})}$$

Determined by using the balanced equation

$$\frac{0.825 \text{ moles H}_2\text{SO}_4}{\text{liters of H}_2\text{SO}_4 \text{ solution}} * 0.00250 \text{ L H}_2\text{SO}_4 * \frac{2 \text{ moles NaOH}}{1 \text{ mole H}_2\text{SO}_4} * \frac{1 \text{ liter of NaOH}}{0.215 \text{ m NaOH}} = 0.0191 \text{ L NaOH}$$

1.91 ml NaOH