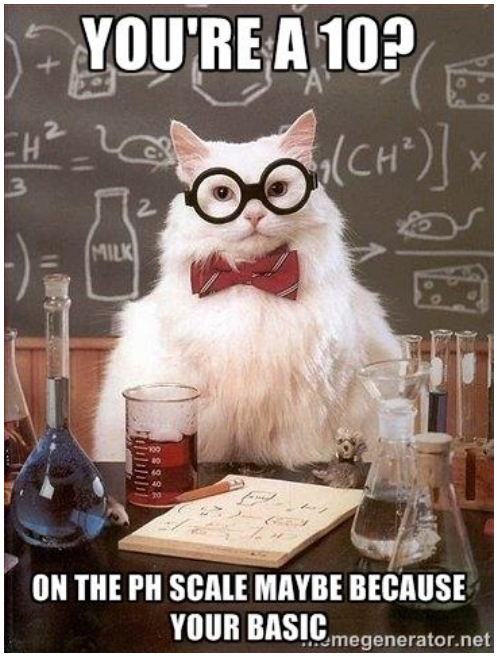
Name:

Regents Chemistry:

Practice Packet Unit 10: Acids and Bases



Vocabulary

For each word, provide a short but specific definition from YOUR OWN BRAIN! No boring textbook definitions. Write something to help you remember the word. Explain the word as if you were explaining it to an elementary school student. Give an example if you can. Don't use the words given in your definition!

Acid: _____

Base: _____

Salt: _____

Electrolyte: _____

Molarity: _____

Neutralization: _____

Titration: _____

End Point: _____

Lesson 1: Arrhenius Acids and Bases

Objective:

- ***Differentiate between an a Arrhenius Acid & Base***
- ***Identify properties of acids and bases***

- Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acid and bases are electrolytes.
- An _____is a substance which, when dissolved in water, forms a solution capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.
- Arrhenius acids yield _____ as the only positive ion in an aqueous solution. The hydrogen ion may also be written as H_3O^+ (aq), hydronium ion.
- Arrhenius bases yield _____as the only negative ion in an aqueous solution.

1. Properties of acids: 1. Contain the _____ ion

2. Tastes_____

3. pH _____

4. Found on Table ____

Bases: 1. Contain the _____ ion

2. Tastes _____

3. pH _____

4. Found on table ____

2. Acids and Bases are known as _____ because when dissolved they conducted electricity.

PRACTICE PROBLEMS

1. Use Table K and Table L to help you identify the rules for determining whether a substance is an acid, a base, or a salt based on the formula. Label each as an acid, base, or salt. Leave the covalent substances alone.

NH_3	NaCl	CH_3OH	H_2SO_4	$Ca(OH)_2$	CH_4
NH_4Br	HCl	Na_2SO_4	HNO_3	CH_3COOH	NaOH
H_3PO_4	LiOH	$CH_2(OH)_2$	NH_4OH	$Ca(NO_3)_2$	$HC_2H_3O_2$

- All acids have the _____ ion in common.
- All bases have the _____ ion in common.
- All salts have formulas that contain: _____
- Organic acids have the general formula: _____
- Draw ethanoic acid and show which H^+ ion is lost:

Fill in the table indicating if the property is characteristic of an acid or base

Property	Acid or Base	Property	Acid or Base
Tastes sour		Tastes Bitter	
Hydrolyzes Fats into soap		Reacts with active metals to for H_2	
HCl(aq)		KOH(aq)	
pH of 12		Forms H_3O^+	

2. Which formula represents a hydronium ion?
   (1) H_3O^+ (2) OH^- (3) NH_4^+ (4) HCO_3^-

3. Which compound is an Arrhenius acid?
   (1) H_2SO_4 (2) NaOH (3) KCl (4) NH_3

4. Which substance is an Arrhenius acid?
   (1) $Ba(OH)_2$ (2) H_3PO_4 (3) CH_3COOCH_3
   (4)NaCl

5. Which compound releases hydroxide ions in an aqueous solution?
   (1) CH_3COOH (2) HCl (3) CH_3OH (4) KOH

6. The Arrhenius theory explains the behavior of
   (1) acids and bases
   (2) alcohols and amines
   (3) isomers and isotopes
   (4) metals and nonmetals

7. Which two compounds are electrolytes?
   (1) $C_6H_{12}O_6$ and CH_3CH_2OH
   (2) $C_6H_{12}O_6$ and HCl
   (3) NaOH and HCl
   (4) NaOH and CH_3CHOH

8. An aqueous solution of lithium hydroxide contains hydroxide ions as the only negative ion in solution. Lithium hydroxide is classified as an
   (1) aldehyde (3) Arrhenius acid
   (2) alcohol (4) Arrhenius base

9. Which compound is an Arrhenius acid?
   (1) H_2SO_4 (3) NaOH
   (2) KCl (4) NH_3

10. Which two formulas represent Arrhenius acids?
    (1) CH_3COOH and CH_3CH_2OH
    (2) $HC_2H_3O_2$ and H_3PO_4
    (3) $KHCO_3$ and $KHSO_4$
    (4) NaSCN and $Na_2S_2O_3$

11. According to the Arrhenius theory, an acid is a substance that
    (1) changes litmus from red to blue
    (2) changes phenolphthalein to pink
    (3) produces hydronium ions as the only positive ions in an aqueous solution
    (4) produces hydroxide ions as the only negative ions in an aqueous solution

12. Which formula represents a hydronium ion?
    (1) H_3O^+ (2) OH^- (3) NH_4^+ (4) HCO_3^-

13. Which substance is an Arrhenius acid?
    (1) $Ba(OH)_2$ (2) H_3PO_4 (3) CH_3COOCH_3 (4) NaCl

14. Which compound releases hydroxide ions in an aqueous solution?
    (1) CH_3COOH (2) HCl (3) CH_3OH (4) KOH

15. Which substance is an Arrhenius base?
    (1) CH_3OH (2) LiOH (3) CH_3Cl (4) LiCl

16. The only positive ion found in $H_2SO_4(aq)$ is the
    (1) ammonium ion (3) hydronium ion
    (2) hydroxide ion (4) sulfate ion

17. Which substance, when dissolved in water, forms a solution that conducts an electric current?
    (1) C_2H_5OH (3) $C_{12}H_{22}O_{11}$
    (2) $C_6H_{12}O_6$ (4) CH_3COOH

Acids and Table J

acid + more active metal → H_2(g) + a salt

Any metal ABOVE H_2 in the table will react with acids to produce H_2 (g) and a salt.
Any metal below H_2 in the table will NOT react with an acid (only 3 metals do NOT react with acids: Cu, Au, Ag)
When metals react with acids, this is an example of a SINGLE REPLACEMENT reaction.

Predict the products of the following reactions:

$Zn\ (s) + 2HCl\ (aq) \rightarrow$ _____ + _____

$Ag\ (s) + H_2SO_4\ (aq) \rightarrow$ _____ + _____

$Ca\ (s) + H_2SO_4\ (aq) \rightarrow$ _____ + _____

1. According to Reference Table J, which of these metals will react most readily with 1.0 M HCl to produce H_2(g)?

(1) Ca (2) K (3) Mg (4) Zn

2. Under standard conditions, which metal will react with 0.1 M HCl to liberate hydrogen gas?

(1) Ag (2) Au (3) Cu (4) Mg

3. Because tap water is slightly acidic, water pipes made of iron corrode over time, as shown by the balanced ionic equation below. Explain, in terms of chemical reactivity, why copper pipes are less likely to corrode than iron pipes.

$$2Fe(s) + 6H^+(aq) \rightarrow 2Fe^{3+}(aq) + 3H_2(g)$$

4. Many ancient cultural statues and buildings were made out of marble. Marble is a type of rock which contains the metal calcium in it. Explain, using Table J, why marble statues are damaged by acid rain.

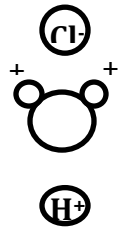
5. During a laboratory activity, a student reacted a piece of zinc with 0.1 M HCl(aq).

(a) Complete the equation below by writing the formula of the missing products.

$Zn + HCl \rightarrow$ ____ + _____

(b) Identify one metal that does not react spontaneously with HCl(aq). _____

When an acid dissolved it dissociates or ionizes (breaking up into two ions). The ions are separated due to the polarity of water, as shown below in the 1st box. Draw what happens to the acid, base, and salt in water in the other boxes.

$HCl(g) + H_2O(l) \rightarrow HCl(aq)$	$HNO_3(g) + H_2O(l) \rightarrow HNO_3(aq)$	$NaOH(g) + H_2O(l) \rightarrow NaOH(aq)$	$NaCl(g) + H_2O(l) \rightarrow NaCl(aq)$
			

Explain why they are known as electrolytes when in solution but not when they are in solid or gas phases.

Lesson 2: Alternate Theory of Acids and Bases (Bronsted Lowry)

Objective:

- ***Differentiate between a Brønsted Lowry Acid and Base***

Acids are defined as proton (H^+) donators. They donate protons to the base. Bases are defined as proton acceptors. They accept protons from the acid.

$$HCl + NH_3 \longleftrightarrow NH_4^+ + Cl^-$$

According to Bronsted-Lowry theory, acid-base reactions involve a transfer of a proton. Above, the acid on the left, _____, transfers (donates) a proton (H^+) and becomes a base (for the reverse reaction) on the right, _____. The donating acid and the base it becomes are called *conjugate acid - base pairs.* The base on the left, _____, accepts a proton (H^+) and becomes an acid (for the reverse reaction) on the right, _____. This is also a conjugate pair.

$$HCl_{(aq)} + H_2O_{(l)} \longleftrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)} \quad (1)$$
$$HCl_{(aq)} + NH_{3(aq)} \longleftrightarrow NH_4^+_{(aq)} + Cl^-_{(aq)} \quad (2)$$
$$NH_4^+_{(aq)} + OH^-_{(aq)} \longleftrightarrow NH_{3(aq)} + H_2O_{(l)} \quad (3)$$
$$H_2PO_{4(aq)} + H_2O_{(l)} \longleftrightarrow HPO_4^{2-}_{(aq)} + H_3O^+_{(aq)} \quad (4)$$

1. In the reactions above, list the acids in the reactants and explain what they all have in common.

2. In the reactions, list the bases in the first half of the equation and explain what they all have in common.

3. If you reverse the equations, list the new acids and bases.
   Acids: Bases:

4. Now you can see, that each acid on the left hand side produces a corresponding base on the right hand side. The base is called the **conjugate base**. Similarly, a base on the right hand side will produce a **conjugate acid**. These pairs are known as **conjugate acid-base pairs**. List the conjugate acid-base pairs for equations (1) and (2).

5. Write the acid-base reaction for NH_3 reacting with HNO_2 and identify the acid, the base, the conjugate acid and the conjugate base.

___6. One acid-base theory defines a base as an
(1) H^+ donor (2) H donor (3) H^+ acceptor (4) H acceptor

___7. One alternate acid-base theory states that an acid is a(n)
(1) H^+ donor (2) OH^- donor (3) H^+ acceptor (4) OH^- acceptor

___8. According to one acid-base theory, a water molecule acts as an acid when the water molecule
(1) accepts an H+ (2) accepts an OH– (3) donates an H+ (4) donates an OH–

___9. Given the equation representing a reaction at equilibrium:
$NH_3(g) + H_2O(l) \leftrightarrow NH_4^+(aq) + OH^-(aq)$

The H^+ acceptor for the forward reaction is
(1) H_2O (l) (2) NH_4^+ (aq) (3) NH_3 (g) (4) OH^- (aq)

___10. Which formula represents a hydronium ion?
(1) H_3O^+ (2) OH^- (3) NH_4^+ (4) HCO_3^-

___11. Given the balanced equation representing a reaction:
$NH_3(g) + H_2O(l) \leftrightarrow NH_4^+(aq) + OH^-(aq)$

According to one acid-base theory, the $NH_3(g)$ molecules act as
(1) an acid because they accept H^+ ions
(2) an acid because they donate H^+ ions
(3) a base because they accept H^+ ions
(4) a base because they donate H^+ ions

___12. Which statement describes an alternate theory of acids and bases?
(1) Acids and bases are both H^+ acceptors.
(2) Acids and bases are both H^+ donors.
(3) Acids are H^+ acceptors, and bases are H^+ donors.
(4) Acids are H^+ donors, and bases are H^+ acceptors.

___13 Which substance, when dissolved in water, forms a solution that conducts an electric current?
(1) C_2H_5OH (2) $C_{12}H_{22}O_{11}$ (3) $C_6H_{12}O_6$ (4) CH_3COOH

Lesson 3: pH Scale and Indicators

Objective:

- ***Differentiate between an Acid and Base on the pH scale***
- ***Determine the change in H+ or OH- concentration during a change in pH***

The pH scale is a measure of the H^+ or H_3O^+ concentration in a solution. "pH" stands for "potential to ATTRACT Hydrogen ions"

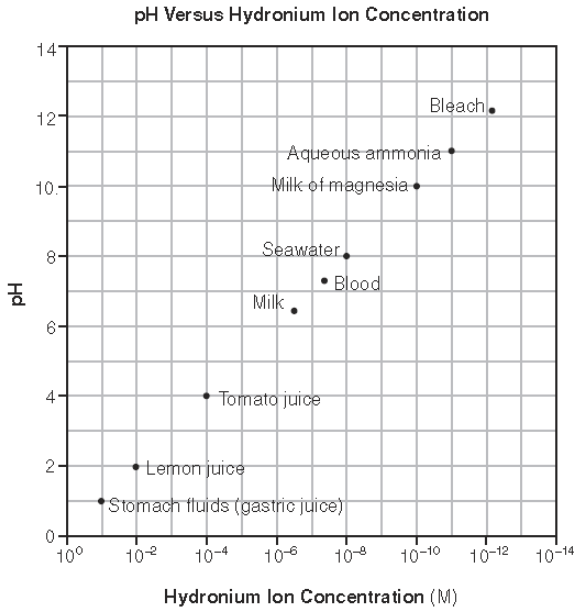
- **Acids have a LOW pH (a LOW potential to attract H^+ ions (release/DONATE H^+)**
- **Bases have a HIGH pH (a HIGH potential to attract H^+ ions (bases are H^+ acceptors)**

The pH scale is logarithmic, which means that a change of *one* pH unit will change the concentration of H^+ by a factor of 10.

1. Label the pH scale below in terms of acid, base and neutral.

1	2	3	4	5	6	7	8	9	10	11	12	13	14

2. Complete the table using the grid below:



	Hydronium Ion Concentration (M)	pH	Acid or Base?
Stomach fluids			
Lemon Juice			
Blood			
Seawater			
Bleach			

3. Circle one to complete the table

	If an ACID is added…	**If a BASE is added…**
pH	Increases or Decreases	Increases or Decreases
$[H^+]$ or $[H_3O^+]$	Increases or Decreases	Increases or Decreases
$[OH^-]$	Increases or Decreases	Increases or Decreases
Solution becomes more	Acidic or Basic	Acidic or Basic

Recall the following:

- **increasing or decreasing the pH by 1 changes the $[H^+]$ by a factor of 10^1 (10 times, "ten-fold")**
- **increasing or decreasing the pH by 2 changes the $[H^+]$ by a factor of 10^2 (100 times, hundred-fold)**
- **increasing or decreasing the pH by 3 changes the $[H^+]$ by a factor of 1000 (thousand-fold)**

4. Describe what happens to the concentration of hydrogen ions in a solution if the pH is changed from 7 to 5.

5. Describe what is happening to the concentration of hydrogen ions in a solution if the pH is changed from 5 to 8.

6. Complete the table below:

pH Change	$[H_3O^+]$ increase or decrease?	$[OH^-]$ increase or decrease?	Does the solution become more acidic or basic?	By a factor of…
6 to 8				
8 to 5				
3 to 7				
11 to 9				
14 to 13				
4 to 8				

7. Which of these pH numbers indicates the highest level of acidity?
(1) 5 (2) 10 (3) 8 (4) 12

8. Which change in pH represents a hundredfold increase in the concentration of hydronium ions in a solution?
(1) pH 1 to pH 2
(2) pH 1 to pH 3
(3) pH 2 to pH 1
(4) pH 3 to pH 1

9. The pH of a solution changes from 4 to 3 when the hydrogen ion concentration in the solution is
(1) decreased by a factor of 100
(2) decreased by a factor of 10
(3) increased by a factor of 100
(4) increased by a factor of 10

10. Solution A has a pH of three and solution Z has a pH of six How many times greater is the hydronium ion concentration in solution A than the hydronium ion concentration in solution Z?
(1) 100 (2) 3 (3) 2 (4) 1000

11. What is the pH of a solution that has a hydronium ion concentration 100 times greater than a solution with a pH of 4?
(1) 5 (2) 3 (3) 2 (4) 6

Indicators

How to use Table M:
- If the pH is below the first number, the solution will be the first color listed
- If the pH is above the second number, the solution will be the second color listed
- If the pH is between the numbers, the solution will be a mix of the two colors

Ex: If you add bromthymol blue… to a solution with a pH of 8, it will be blue
to a solution with a pH of 7, it will be green
to a solution with a pH of 5, it will be yellow

1. Which indicator, when added to a solution, changes color from yellow to blue as the pH of the solution is changed from 5.5 to 8.0?
(1) bromcresol green
(2) bromthymol blue
(3) litmus
(4) methyl orange

2. Which indicator would best distinguish between a solution with a pH of 3.5 and another with a pH of 5.5?
(1) bromthymol blue (3) litmus
(2) bromcresol green (4) thymol blue

3. In which solution will bromcresol green appear blue?
(1) 1 M NaCl (3) 1 M NH_3
(2) 1 M H_2CO_3 (4) 1 M CH_3COOH

4. In which solution will thymol blue indicator appear blue?
(1) 0.1 M CH_3COOH (3) 0.1 M KOH
(2) 0.1 M HCl (4) 0.1 M H_2SO_4

5. What is the color of the indicator methyl orange in a solution that has a pH of 2?
(1) blue (3) yellow
(2) orange (4) red

6. In a solution with a pH of 3, what color is bromcresol green?
(1) yellow (3) green
(2) blue (4) red

7. At what pH will bromothymol blue be yellow and bromocrescol green be blue?
(1) 10.5 (2) 5.7 (3) 7.0

Lesson 4: Neutralization and Titrations

Objective:

- ***Describe a neutralization reaction***
- ***Calculate the concentration of an unknown acid or base using the titration formula***

Neutralization

When an acid and base react, it is a _D_____ __R_____ reaction with the products being _____ and _____.

Neutralization Reactions: If equal mole amounts of acid and base are added together, the resulting solution is NEUTRAL!

Acid + Base → Salt + Water

Example: $HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$

1. Predict the products of and balance the following reactions (remember cation comes first in a compound):

___ $HF\ (aq)$ + ___ $LiOH\ (aq) \rightarrow$ _____ (aq) + ___ $HOH\ (l)$

___ $HNO_3\ (aq)$ + ___ $KOH\ (aq) \rightarrow$ _____(aq) + ___ $HOH\ (l)$

___ $HCl\ (aq)$ + ___ $Ca(OH)_2\ (aq) \rightarrow$ _____(aq) + ___ $HOH\ (l)$

___ $HClO_3\ (aq)$ + ___ $Mg(OH)_2\ (aq) \rightarrow$ _____(aq) + ___ $HOH\ (l)$

___ $H_2CO_3\ (aq)$ + ___ $NaOH\ (aq) \rightarrow$ _____(aq) + ___ $HOH\ (l)$

2. What are the products of a reaction between KOH(aq) and HCl(aq)?
   (1) H_2 and KClO (3) H_2O and KCl
   (2) KH and HClO (4) KOH and HCl

3. Which word equation represents a neutralization reaction?
   (1) base + acid →salt + water
   (2) base + salt →water + acid
   (3) salt + acid →base + water
   (4) salt + water →acid + base

4. Which compound could serve as a reactant in a neutralization reaction?
(1) NaCl (3) CH_3OH
(2) KOH (4) CH_3CHO

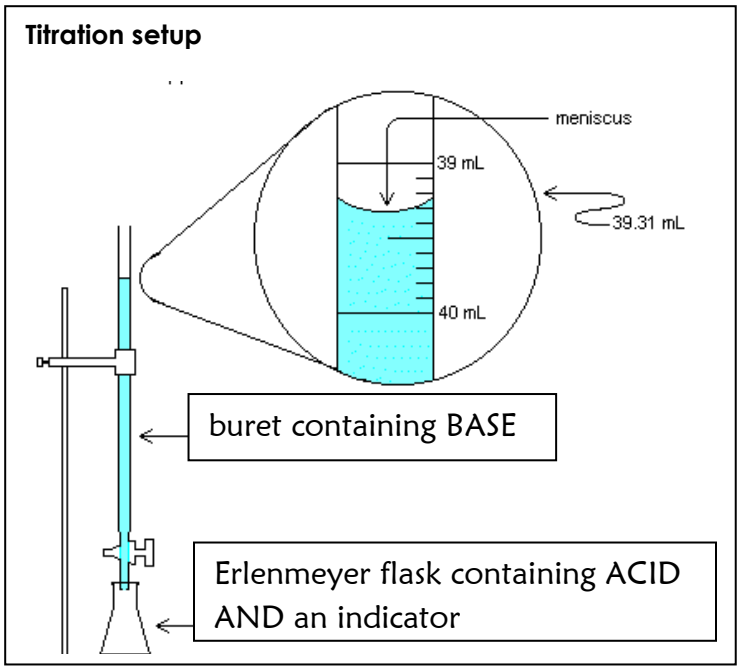
5. Which substance can be a product when an Arrhenius acid in an aqueous solution reacts with an Arrhenius base in an aqueous solution?
(1) HBr (3) KBr
(2) H_2O (4) KOH

6. Which reactants form the salt $CaSO_4(s)$ in a neutralization reaction?
(1) $H_2S(g)$ and $Ca(ClO_4)_2(s)$
(2) $H_2SO_3(aq)$ and $Ca(NO_3)_2(aq)$
(3) $H_2SO_4(aq)$ and $Ca(OH)_2(aq)$
(4) $SO_2(g)$ and $CaO(s)$

7. Sulfuric acid, $H_2SO_4(aq)$, can be used to neutralize barium hydroxide, $Ba(OH)_2(aq)$. What is the formula for the salt produced by this neutralization?
(1) BaS (3) $BaSO_3$
(2) $BaSO_2$ (4) $BaSO_4$

8. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?
(1) $HC_2H_3O_2(aq) + NaOH(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l)$
(2) $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(l)$
(3) $Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
(4) $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2\ NaCl(aq)$

Titrations are procedures used to determine the concentration (M) of an acid or a base. You combine together an acid and a base knowing the volume of each and the concentration of only one of them.



1. What number would be at the top of the buret?
2. Read the volume of the base in the buret.
3. If the buret holds 50mL, how much base is actually in the buret?
4. If a student started at 2.0mL and released base until it was at the level shown, how much bases was added?
5. Why is it not necessary to subtract all your volumes from

Titration Problems

1. A 25.0-milliliter sample of HNO_3 (aq) is neutralized by 32.1 milliliters of 0.150 M KOH (aq). What is the concentration of the acid?

2. How many milliliters of 0.200 M NaOH are needed to neutralize 100. mL of 0.100 M HCl?

3. In a titration, 20.0 milliliters of 0.15 M HCl(aq) is exactly neutralized by 18.0 milliliters of KOH(aq).

(a) Complete the equation below for the neutralization reaction by writing the formula of *each* product.

$KOH(aq) + HCl(aq) \rightarrow$ _____ + _____

(b) Compare the number of moles of $H^+(aq)$ ions to the number of moles of $OH^-(aq)$ ions in the titration mixture when the HCl(aq) is exactly neutralized by the KOH(aq).

(c) Determine the concentration of the KOH(aq).

(d) What is the new pH of the solution?

1. In a laboratory activity, 0.500 mole of NaOH(s) is completely dissolved in distilled water to form 400. milliliters of NaOH(aq). This solution is then used to titrate a solution of HNO_3(aq).

(a) Identify the negative ion produced when the NaOH(s) is dissolved in distilled water.

(b) Calculate the molarity of the NaOH(aq). Your response must include *both* a correct numerical setup and the calculated result.

(c) If 26.4 milliliters of the NaOH solution is needed to exactly neutralize 44.0 milliliters of the HNO_3 solution, what is the molarity of the HNO_3 solution?

(d) Complete the equation below representing this titration reaction by writing the formulas of the products.

$$NaOH(aq) + HNO_3(aq) \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

Adjustment for multiple H^+ or OH^-:

$H_3PO_4 + H_2O \rightarrow 3H_3O^+ + PO_4^{-3}$ **$H_2SO_4 + H_2O \rightarrow 2H_3O^+ + SO_4^{-2}$**

What happens when an acid has two or more hydrogen atoms? Do they just lose one? Strong acids completely ionize leaving no hydrogen atoms in the anion or conjugate base. This means we need to amend out titration formula for these special acids to include all the acidic ions that come off.

$Ca(OH)_2 + H_2O \rightarrow 2OH^- + Ca^{+2}$ **$Mg(OH)_2 + H_2O \rightarrow 2OH^- + Mg^{+2}$**

Similarly, what happens when a base has two or more hydroxide ions? Do they just lose one? Strong bases completely ionize leaving no hydroxide ions in the cation. This means we need to amend our titration formula for these special bases to include all the basic ions that come off.

The $M_aV_a = M_bV_b$ formula will have coefficients in front of the M corresponding to the number of H^+ or OH^- in the acid and base formula.

Example: If 35.0mL of 3.00M H_3PO_4 is neutralized by 50.0mL of $Ca(OH)_2$, what is the molarity of the base?

$M_aV_a = M_bV_b$ becomes $(\#H^+)(M_a V_a) = (\#OH^-)(M_b V_b)$

$3(3)(35) = 2(x)(50)$

$x = 3.15M$

1. If 65.0mL of 1.50M H_3PO_4 is neutralized by 25.0mL of $Ca(OH)_2$, what is the molarity of the base?

2. If 15.0mL of 3.50M H_2SO_4 is neutralized by 25.0mL of $Mg(OH)_2$, what is the molarity of the base?

3. If 150.0mL of 4.50M HNO_3 is neutralized by 3.00M $Mg(OH)_2$, what is the volume of the base added?

4. If 25.5mL H_3PO_4 is neutralized by 50.0mL of 2.00M LiOH, what is the molarity of the acid?

5. If 35.0mL of H_2CO_3 is neutralized by 50.0mL of 1.50M KOH, what is the molarity of the acid?

6. If 6.00M HI is neutralized by 50.0mL of 4.50M RbOH, what is the volume of the acid added?

More Practice:

1. A 25.0-milliliter sample of $HNO_3(aq)$ is neutralized by 32.1 milliliters of 0.150 M KOH(aq). What is the molarity of the $HNO_3(aq)$?

2. A 25.0 mL sample of 5.00 M HCl is required to neutralize 34.5 mL of NaOH solution, what is the concentration of the NaOH solution?

3. A total of 50.0 mL of 0.50 M KOH solution completely neutralizes 125 mL of hydrobromic acid solution (HBr). Calculate the concentration of the HBr solution.

4. What volume of 0.10 M NaOH(aq) exactly neutralizes 15.0 milliliters of 0.20 M $HNO_3(aq)$?

Regents Practice: Titrations

1. What are the products of a reaction between KOH(aq) and HCl(aq)?
(1) H_2 and KClO (2) H_2O and KCl
(3) KH and HClO (4) KOH and HCl

2. Which word equation represents a neutralization reaction?
(1) base + acid →salt + water
(2) base + salt →water + acid
(3) salt + acid →base + water
(4) salt + water →acid + base

3. Which compound could serve as a reactant in a neutralization reaction?
(1) NaCl (3) CH_3OH
(2) KOH (4) CH_3CHO

4. Which substance is always a product when an Arrhenius acid in an aqueous solution reacts with an Arrhenius base in an aqueous solution?
(1) HBr (3) KBr
(2) H_2O (4) KOH

5. Which reactants form the salt $CaSO_4(s)$ in a neutralization reaction?
(1) $H_2S(g)$ and $Ca(ClO_4)_2(s)$
(2) $H_2SO_3(aq)$ and $Ca(NO_3)_2(aq)$
(3) $H_2SO_4(aq)$ and $Ca(OH)_2(aq)$
(4) $SO_2(g)$ and CaO(s)

6. Sulfuric acid, $H_2SO_4(aq)$, can be used to neutralize barium hydroxide, $Ba(OH)_2(aq)$. What is the formula for the salt produced by this neutralization?
(1) BaS (3) $BaSO_3$
(2) $BaSO_2$ (4) $BaSO_4$

7. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?
(1) $HC_2H_3O_2 + NaOH \rightarrow NaC_2H_3O_2 + H_2O$
(2) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
(3) $Zn + 2\ HCl \rightarrow ZnCl_2 + H_2$
(4) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2\ NaCl$

8. Which volume of 0.10 M NaOH(aq) exactly neutralizes 15.0 milliliters of 0.20 M $HNO_3(aq)$?
(1) 1.5 mL (3) 3.0 mL
(2) 7.5 mL (4) 30. mL

9. In which laboratory process could a student use 0.10 M NaOH(aq) to determine the concentration of an aqueous solution of HBr?
(1) chromatography
(2) decomposition of the solute
(3) evaporation of the solvent
(4) titration

10. The data collected from a laboratory titration are used to calculate the
(1) rate of a chemical reaction
(2) heat of a chemical reaction
(3) concentration of a solution
(4) boiling point of a solution

11. Which volume of 0.10 M NaOH(aq) exactly neutralizes 15.0 milliliters of 0.20 M $HNO_3(aq)$?
(1) 1.5 mL (3) 3.0 mL
(2) 7.5 mL (4) 30. mL

12. What volume of 0.120 M $HNO_3(aq)$ is needed to completely neutralize 150.0 milliliters of 0.100 M NaOH(aq)?
(1) 62.5 mL (3) 180. mL
(2) 125 mL (4) 360. mL