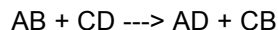


Objective 6. Double replacement reactions 2: balancing acid-base and gas forming reactions, identifying strong and weak acids, write net ionic equations to predict whether a reaction occurs, perform C-V-mole and mole ratio calculations (volumetric)

Quiz Practice problems:

Key ideas: In a double replacement reaction, Compound AB reacts with Compound CD to form Compound AD and Compound CB.



Another type of double replacement reaction is an acid-base reaction. An acid donates H^+ and a base accepts H^+ so a transfer of H^+ occurs in an acid-base reaction.

A gas forming reaction is a type of acid-base reaction. If H_2CO_3 is produced as a product, replace the H_2CO_3 with H_2O and CO_2 gas.

Acids are classified by strength (strong or weak).

A net ionic equation is used to predict whether a reaction occurs.

Skills: Given reactants of a double replacement reaction, predict the products (write chemical formulas) of the reaction.

Balance an acid-base reaction.

Identify an acid as strong or weak.

Write a net ionic equation. Identify spectator ions.

Predict whether a reaction occurs from a net ionic equation.

Perform chemical calculations involving an acid-base reaction.

For solutions, use concentration in Molarity = moles/volume. Use algebra to solve for one of these variables.

1. a. Life consists of give and take. Does an acid give or take H^+ ? Does a base give or take H^+ ?

b. (i) Name an experiment that you can do to identify an acid.

(ii) Name an experiment that you can do to identify a base.

c. Fill in the blanks in the table: (brackets [] mean concentration in M)

$$pH = -\log [H^+]$$

$$[H^+] = 10^{-pH}$$

$$pOH = -\log [OH^-]$$

$$[OH^-] = 10^{-pOH}$$

$$pH + pOH = 14$$

Substance	pH	pOH	$[H^+]$, M	$[OH^-]$, M
Lemon juice	2.4			
Stomach acid = HCl	2.5			
Milk		7.5		
blood				2.51×10^{-7}
Household ammonia			3.16×10^{-12}	
0.15 M NaOH				

2. What ions are in the following acids and bases?

a. muriatic acid = HCl

b. lye = NaOH

c. acetic acid = $HC_2H_3O_2$

d. washing soda = sodium carbonate

You can predict whether an acid-base reaction occurs if you can write a net ionic equation.

3. For each reaction,

Predict the products. If H_2CO_3 is produced as a product, replace the H_2CO_3 with H_2O and CO_2 gas.

Balance the equation.

Write a net ionic equation. Strong acids dissociate into ions, e.g., HCl breaks up into H^+ and Cl^- .

Weak acids do not dissociate (actually, only one in a few thousand or million weak acid molecules break up), e.g., $HC_2H_3O_2$ stays as $HC_2H_3O_2$ in an ionic equation.

ID the spectator ions.

a. $HCl + NaOH \rightarrow$

b. baking soda + $HC_2H_3O_2 \rightarrow$

(This is a gas forming reaction.)

c. $KOH + HC_2H_3O_2 \rightarrow$

d. $H_2SO_4 + Na_2CO_3 \rightarrow$

4. Our stomach contains acid, which helps digest food.

a. What happens to this pH when a person gets heartburn? You calculated the pOH, $[H^+]$, and $[OH^-]$ of stomach acid in Question 1.

b. Milk of Magnesia (magnesium hydroxide $(Mg(OH)_2)$) is used in antacids. Describe how an antacid works. Write a balanced molecular equation and net ionic equation that shows how this antacid works. How many moles of antacid reacts with 1 mole of stomach acid?

c. Calculate the mass of HCl that reacts with 500 mg of Milk of Magnesia.

Step 1: write a balanced chemical equation

Step 2: Given the mass of one substance, calculate moles:

500 mg $Mg(OH)_2$ ---> _____ moles of $Mg(OH)_2$

Step 3: Use coefficients to determine mole ratio:

1 moles $Mg(OH)_2$ to 2 moles HCl so

_____ moles of $Mg(OH)_2$ ---> _____ moles of HCl

Step 4: What conversion to do next?

5. a. Alka-Selzer (Baking soda, $NaHCO_3$) and Tums (calcium carbonate $(CaCO_3)$) are used in antacids. For each antacid, write a balanced molecular equation and net ionic equation that shows how each antacid works. For each antacid, how many moles of antacid reacts with 1 mole of stomach acid?

(Answer: $CaCO_3 + 2 HCl \rightarrow CaCl_2 + H_2O + CO_2$ for Tums)

b. Antacid commercial: "How many times its weight in excess stomach acid does (antacid) neutralize?"

(i) Calculate the moles of HCl that reacts with 0.50 moles of baking soda.

(ii) Calculate the mass of HCl that reacts with 500 mg of baking soda.

(iii) How many g of HCl reacts with 500 mg of $CaCO_3$?

(iv) Based on your answers from parts (ii) and (iii), which antacid is more effective? Give reasons.

c. Which antacid, Milk of Magnesia or Alka-Selzer or Tums, will make you burp?

d. 550 mg of $CaCO_3$ is added to 100 ml of pH 1.5 HCl.

(i) How many moles of HCl are present?

a. 0.15 b. 0.032 c. 0.0032

(ii) The limiting reactant is:

a. $CaCO_3$ b. HCl c. H_2O

(iii) How many g of CO_2 are produced?

a. 0.070 b. 1.4 c. 0.48

A titration is performed to accurately determine the concentration of an acid or base. Usually, the base is in the buret and is added (titrated) to an acid.

6. You prepare a solution of NaOH from NaOH solid. You transfer this solution to a buret. You will titrate a known volume and concentration of HCl to determine the concentration of NaOH.

You pipet 10.00 ml of 0.923 M HCl into a flask. You add one drop of phenolphthalein. 12.76 ml of NaOH is needed to turn this solution pink for 15 to 30 seconds.

a. Write a chemical equation that represents the HCl-NaOH reaction.

b. for solutions: Molar concentration = moles/volume in liters.

Calculate the moles of HCl in 10.00 ml of 0.923 M HCl. (What is the conversion factor?)

c. Calculate the moles of NaOH that reacts with HCl. (What is the conversion factor?)

d. Calculate the concentration of the NaOH solution. (Answer: between 0.7 and 0.75 M)

Limiting and excess reactants:

7. You pipet 10.00 ml of 0.923 M HCl into a flask. You add one drop of phenolphthalein. You titrate this solution with 0.73 M NaOH (the NaOH is in a buret).

a. You add 1.00 ml of the 0.73 M NaOH. (The solution is not going to be pink.) The NaOH is the limiting reactant.

Calculate the volume of 0.923 M HCl that is leftover.

(i) Calculate the moles of NaOH. (What equation do you want to use?)

(ii) Calculate the moles of HCl that reacts with the NaOH. (What is the conversion factor?)

(iii) Calculate the moles of HCl in 10.00 ml of 0.923 M HCl. This is the original amount of HCl in the flask. (What equation do you want to use?)

(iv) Subtract the moles of HCl that reacts from the original moles of HCl.

(v) Convert moles of HCl to volume of HCl. (What is the conversion factor?)

b. You add 11.00 ml of the 0.73 M NaOH. The NaOH is the limiting reactant. Calculate the volume of 0.923 M HCl that is leftover. What color is the solution?

c. You add 15.00 ml of the 0.73 M NaOH. The NaOH is the excess reactant. Calculate the volume of 0.73 M NaOH that is leftover. What color is the solution?

8. You titrate 15.00 ml of HCl solution with 19.32 ml of 0.157 M KOH. Calculate the concentration of the HCl.

9. You want to determine the concentration of battery acid. 2.00 ml of battery acid is titrated with 31.74 ml of 2.241 M NaOH. What is the concentration of battery acid?

10. a. Phosphoric acid (H_3PO_4), which is an acid is soda, removes rust (Fe_2O_3). This means you can use soda to remove rust from a rusty part. Write a balanced chemical equation and net ionic equation.

b. You add 1 can (355 ml) of soda (assume 0.05 M H_3PO_4) to 1.0 g of rust (from a rusty nail). Is this enough soda to remove the rust? In other words, the limiting reactant is _____. Calculate the amount of excess reactant leftover.

c. The reaction of rust with sulfuric acid is faster than the reaction of rust with acetic acid. Write balanced chemical equations and net ionic equations to explain why one reaction is faster than the other.

11. You can buy hydrochloric acid at a hardware store as muriatic acid. Hydrochloric acid is used commercially in the "pickling" of steel. Pickling consists of dipping steel into an acid bath to remove rust (Fe_2O_3) from its surface before processing the steel into finished goods.



a. Balance the chemical equation. Write a net ionic equation.

b. If 0.5 moles of rust are present, calculate the moles of acid that reacts.

c. You have 10.0 g of rust. Calculate the mass of acid that reacts with all of the rust and the mass of each product (theoretical yield) that is produced when 10.0 g of rust reacts.

d. The % yield of FeCl_3 is 75%. Calculate the actual yield of FeCl_3 .