SNC2D CHEMISTRY

CHEMICAL REACTIONS

- Neutralization Reactions (P.204-212)

pH & Plants

Growing plants for a living can be risky. Many factors can affect the success of a crop, from weather conditions to the nutrient content of the soil. Soil pH is one of these factors. The pH of soil affects the growth of plants in a number of ways. For example, growers can change the colour of hydrangea flowers by changing the soil pH.

NOTE!

When the pH is 6.0 to 6.2, hydrangea flowers are pink. When the soil pH is 5.2 to 5.5, the flowers are blue.

pH & Plants

Once soil pH is known, growers can use this information in one of two ways.

① *They could plant crops that are most suited to the soil pH. For example, legumes (beans and peas) grow best at a pH of 6.2 or higher, but corn does well in soils with a pH as low as 6.0*

pH & Plants

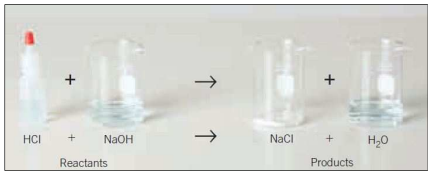
Once soil pH is known, growers can use this information in one of two ways.

② *A grower can adjust the pH of the soil to support particular plants. For example,*
- *If the soil is too acidic, adding a basic substance can increase the pH.*
- *If the soil is too basic, then adding acidic substances can lower the pH.*

Neutralization

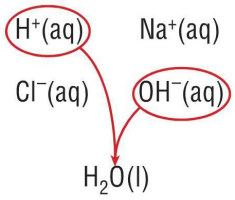
Neutralization *is a chemical reaction between an acid and a base that forms products that have a pH closer to 7 than either of the reactants. These products are usually an ionic compound (sometimes called a "salt") and water. A neutralization reaction can be summarized as follows:*

acid + base ➜ salt + water



Neutralization

As you know, acids form hydrogen ions (H^+) in water, and most bases release hydroxide ions (OH^-). So when an acid and a base are mixed, the hydrogen ions and the hydroxide ions quickly react to produce water, which is neutral and has a pH of around 7.



Neutralization

NEUTRALIZATION

- chemical reaction in which an acid and a base react to form an ionic compound (a salt) and water

acid + base ➜ salt + water

- the resulting pH is closer to 7 (neutral)

Neutralization

PRACTICE

1. Write (i) word equations and (ii) balanced chemical equations to represent the reaction between the following pairs of substances.

   (a) hydrochloric acid (HCl) and potassium hydroxide (KOH)

   (a) hydrochloric acid + potassium hydroxide ➜ potassium chloride + water

   1 HCl + 1 KOH ➜ 1 KCl + 1 H_2O

Neutralization

PRACTICE

1. Write (i) word equations and (ii) balanced chemical equations to represent the reaction between the following pairs of substances.

   (b) sulphuric acid (H_2SO_4) and sodium hydroxide (NaOH)

   (b) sulphuric acid + sodium hydroxide ➜ sodium sulphate + water

   1 H_2SO_4 + 2 NaOH ➜ 1 Na_2SO_4 + 2 H_2O

Neutralization

PRACTICE

2. The chemical equation below represents the cleanup for the hazardous spill of a base:

$$1\ H_3PO_4 + 3\ KOH \rightarrow 1\ K_3PO_4 + 3\ H_2O$$

(a) What type of reaction is this?

(a) double displacement

Neutralization

PRACTICE

2. The chemical equation below represents the cleanup for the hazardous spill of a base:

$$1\ H_3PO_4 + 3\ KOH \rightarrow 1\ K_3PO_4 + 3\ H_2O$$

(b) Write the general equation for this kind of reaction.

(b) AB + CD → AD + CB

Neutralization

PRACTICE

2. The chemical equation below represents the cleanup for the hazardous spill of a base:

$$1\ H_3PO_4 + 3\ KOH \rightarrow 1\ K_3PO_4 + 3\ H_2O$$

(c) How do you think the pH of the products compared to the pH of the initial spill?

(c) pH of reactants – acid (<7) and a base (>7)
pH of products – neutral

Applications of Neutralization

Neutralization reactions have numerous commercial uses including:

- *manufacturing – if the pH of a solution can be changed from basic to acidic (or vice versa) a precipitate can be formed and filtered off*
- *agriculture – when calcium carbonate is added to acidic soil, the soil pH becomes more basic*
- *food industry – fish is a weak base so when lemon juice is added, the pH is lowered and the fishy odour is eliminated*
- *medicine – when a person takes an antacid, the stomach acid becomes more basic*
- *home – oven cleaner is a strong base and can be cleaned up with a solution of vinegar (acetic acid) in water*
- *environmental challenges – chemical spills and acid rain*

Environmental Challenges – Chemical Spills

One environmental challenge is chemical spills. For example, sulphuric acid and sodium hydroxide (also called caustic soda) are two of the most widely used industrial chemicals. Huge quantities of these corrosive chemicals are transported annually by truck, rail, or ship. Even with strict laws controlling how industrial chemicals are transported, accidents happen.

Environmental Challenges – Chemical Spills

For example, on March 31, 2007, a train was hauling 150 000 L of sulphuric acid near Englehart in Northern Ontario when the train suddenly derailed and spilled some of its cargo into the Blanche River. An ecological disaster occurred – dead fish washed up on shore, and local residents were warned not to allow their livestock to drink river water.

Environmental Challenges – Chemical Spills

The emergency response crew added calcium oxide (lime), to the river slightly upstream from the spill site. They wanted to neutralize the acid leaking from the containers. The spill team relied on a two-step neutralization reaction:

① $CaO + H_2O \rightarrow Ca(OH)_2$

② $Ca(OH)_2 + H_2SO_4 \rightarrow H_2O + CaSO_4$

Environmental Challenges – Chemical Spills

NOTE!

During this process, the pH of the river water downstream was carefully monitored to ensure that just the right amount of lime was being added.

Environmental Challenges – Acid Precipitation

Another environmental challenge is acid precipitation. ***Acid precipitation*** *is any precipitation that has a pH less than 5.6 (the pH of normal rainwater). The causes of acid precipitation are sulphur dioxide and nitrogen oxides in the atmosphere. These gases undergo chemical reactions that result in the formation of acids, which eventually fall as acid precipitation. For example,*

$SO_2 + O_2 \rightarrow SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

Environmental Challenges – Acid Precipitation

NOTE!

Acid rain with a pH of 2.4 fell during a storm in New England. That's the same pH as vinegar! The pH of rain in Ontario's Muskoka-Haliburton area ranges between 3.9 and 4.4

Environmental Challenges – Acid Precipitation

Acid precipitation affects us in a variety of ways:

- *it can corrode the stone surfaces of buildings and statues and the concrete of roads and bridges (a neutralization reaction)*
- *it can corrode the iron reinforcing rods in structures (acids react with metals)*
- *it can change the pH of the soil in forests, which can cause trees and plants to die*



Environmental Challenges – Acid Precipitation

Acid precipitation affects us in a variety of ways:

- *it can cause the water in lakes, streams, and other freshwater bodies to become more acidic, which can cause fish and other organisms to die*
- *it is related to respiratory problems in children and people with asthma*



Environmental Challenges – Acid Precipitation

NOTE!

In Alberta and Saskatchewan most lakes are naturally protected from the effects of acid precipitation because they are surrounded by limestone (limestone reacts with excess acid to neutralize it). However, this is not true of lakes in Ontario – they are situated on granite which does not react with acids and so they are at a greater risk of acidification.

Environmental Challenges – Acid Precipitation

Fortunately, one way to raise the pH of heavily acidified lakes is by adding lime. The process, though, is time consuming and costly.

Environmental Challenges

ENVIRONMENTAL CHALLENGES

- chemical spills and acid precipitation (pH < 5.6)
- lime (calcium oxide) is used to help neutralize the effects (2 step process) but the process is time consuming and costly

① $CaO + H_2O \rightarrow Ca(OH)_2$

② $Ca(OH)_2 + H_2SO_4 \rightarrow H_2O + CaSO_4$

Environmental Challenges

PRACTICE

3. As you just learned, one way to treat a lake polluted with acid rain is to add calcium hydroxide. Why is this only a short-term "fix" to the acid rain problem for the lake?

unless industry changes its ways, the acid rain will continue to fall so the lake will continue to become acidic

✔ Check Your Learning

1. Why is it important to neutralize an acid spill before attempting to clean it up?

it could be dangerous – strong acids can cause a chemical burn

✔ Check Your Learning

2. Baking soda fizzes, releasing carbon dioxide gas, when it is added to an acid spill.
   (a) What evidence tells you this is a chemical change?
   (b) How could you use this property to tell when the acid is completely neutralized?
   (c) Why is baking soda a good choice for neutralizing acid spills at home?

(a) fizzing – a gas is produced
(b) when the fizzing stops
(c) available everywhere

✔ Check Your Learning

3. Consider these compounds: HCl, KOH, NaCl, H_3PO_4. Which could be used to raise the pH of pool water? lower the pH? Explain.

   to raise the pH you need a base – KOH and H_3PO_4
   to lower the pH you need an acid – HCl

✔ Check Your Learning

4. You can receive temporary relief from acid indigestion by using an antacid that contains a base. Why is it not a good idea to use an antacid routinely?

   stomach juice is meant to be acidic – breaks down food – but if it too basic it won't digest properly

✔ Check Your Learning

5. A student performed an experiment to test the effectiveness of two antacid tablets, brand X and brand Y.
   ① Each tablet was dissolved in 100 mL of water in separate beakers.
   ② A sample of each solution was transferred to its own test tube.
   ③ Phenolphthalein (an indicator) was added to each test tube.
   Note: the solutions turned pink because the pH > 7
   ④ Drops of acid were added until the pink colour disappeared.
   Note: the antacid was neutralized at this point (pH = 7)

✔ Check Your Learning

5. A student performed an experiment to test the effectiveness of two antacid tablets, brand X and brand Y.
   ⑤ The student obtained the following data.

Antacid	Size of sample (mL)	Drops of acid added
X	10	15
Y	10	30

(a) Which antacid is likely to be more effective at neutralizing "acid" indigestion? Explain.

(a) brand Y – since it took more acid to neutralize it (i.e. lower it's pH), brand Y will neutralize a greater quantity of acid than X

✔ Check Your Learning

5. A student performed an experiment to test the effectiveness of two antacid tablets, brand X and brand Y.
   ⑤ The student obtained the following data.

Antacid	Size of sample (mL)	Drops of acid added
X	10	15
Y	10	30

(b) If the brand X solution had a pH of 7.9, was the pH of the brand Y solution likely higher, lower, or the same? Explain.

(b) higher since it took more acid to neutralize it

✔ Check Your Learning

TEXTBOOK

P.206 Q.1-3
P.216 Q.7-10,13-16
P.214 Activity B19: Neutralizing Acidic Lake ... (see next page for details)

NOTE!

- Check your work often – see P.554 of your text.

Activity: Neutralizing Acidic Lake … (B19/P.214)

INSTRUCTIONS

A. Read the activity "B19: Neutralizing Acidic Lake Water Samples".
B. Follow the instructions given (i.e. procedure 1 to 11).
C. Answer the questions given (i.e. analysis 12-16).

NOTE!

- This is a formal lab report. Be sure to use complete sentences, particularly when it asks you to explain, discuss, describe, …
- Make sure you do your "own" work!