

**EVALUATING  
ACADEMIC READINESS  
Revised for  
FOR APPRENTICESHIP TRAINING**

**SCIENCE SKILLS  
pH SCALE**

**AN ACADEMIC SKILLS MANUAL  
for  
The Food Preparation Trades**

This trade group includes the following trades:  
Baker, Cook and  
Retail Meat Cutter

*Workplace Support Services Branch  
Ontario Ministry of Training, Colleges and Universities*

*Revised 2011*

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

**This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.**

---

---

# SCIENCE SKILLS

## pH SCALE

---

*An academic skill required for the study of the  
Food Preparation Trades*

### **INTRODUCTION**

In the food preparation trades, you work with many different materials. Some of these materials are classified as acids and bases. The strength of an acid or base is measured by its pH. Pure water is neutral at around 7 on the pH scale while a base is higher on the scale, measuring between 7 and 14. Acids measure between 7 down to 1. There are situations in the food preparation trades where you need to know what pH is. You will also need to know the effect pH has on different products you use.

Some detergents and cleaners are bases. Often, the stronger the base is, the more effective the cleanser. At the same time, strong bases are caustic and can harm bare skin. Because of the harshness of these products, it is important to know how to handle them safely.

Acids have many uses in food preparation. Citric acid, which is obtained from citrus fruit, is used as a preservative and as a flavouring agent. For example, lemon juice is often used to give a tart flavour to foods. Acetic acid (vinegar) also imparts a sour flavour and is used in most salad dressings, as well as in many other food products.

Checking the pH of meat is a useful tool in achieving ideal conditions for different meat processing procedures. The pH of uncooked sausage is used to control the humidity and temperature of the conditioning room. The pH value of the carcass at 1 hour after slaughter can be used to determine the firmness of the meat. Vacuum packed meat must have a pH of below 5.9 if it is to keep. The pH value can also be used to confirm whether meat has started to spoil.

In this skills manual, we will look at what the terms acidity and alkalinity mean. This skills manual describes the following:

- ◆ Basic subdivisions of matter
- ◆ Acids and bases
- ◆ The pH scale
- ◆ Effects of pH on meat processing
- ◆ Acidity and food preservation

### **BASIC SUBDIVISIONS OF MATTER**

**Matter** is the term used in science to describe anything that has mass and takes up space. This term is so broad that it has been divided into smaller categories.

---

**Atoms** are the building blocks of matter. They in turn are composed of subatomic particles, which include protons, neutrons and electrons.

- Each kind of atom has a specific number of subatomic particles.
- The number of protons in an atom determines what element an atom forms.
- For example, oxygen has eight protons and iron has twenty-six.

### Elements

An **element** is a substance that can't be broken down further into simpler substances.

- An element is made from one kind of *atom*.
- Examples include nitrogen, oxygen, hydrogen, carbon, iron, zinc and potassium .
- Elements can exist in their pure form or they can combine with other elements to form molecular compounds.

### Compounds

When atoms combine, they form **molecules** that are held together by chemical bonds that do not easily break. A **compound** is composed of molecules of two or more elements which are **chemically combined** in a definite proportion.

- A compound has different characteristics than the elements that form it.
  - For example, hydrogen and oxygen are colourless, odourless gases that exist in the air around us.
  - But, when two molecules of the element hydrogen join with one molecule of oxygen, the compound water is formed.
  - Water is completely different from either hydrogen or oxygen.

It takes a very large number of atoms or molecules to form an amount that can be seen by the naked eye. A bottle of water contains an immense number of water molecules.

Some compounds can be dissolved in water to form a solution. A **solution** is a uniform mixture of small particles of two or more substances.

- One substance in a solution is the dissolving agent or the **solvent**.
  - Water is called the universal solvent because it can dissolve many different substances.
- The other substance is the **solute**.
- Usually there is a lot more solvent than solute.

### ACIDS AND BASES

Acids and bases are two classes of chemicals that have generally opposite characteristics. Both acids and bases are often found in solutions with water.

- If they are in a strong solution, they are corrosive or caustic.
- They will damage skin, fabric, plant and animal material, metals and most plastics.
- If they are in properly constructed weak solutions, we can use them to do many useful things.

*Acids taste sour. When dissolved in a solution with water, acids release **hydrogen ions**.*

- A hydrogen ion is a hydrogen atom that has lost its only electron ( $H^+$ ).
- These free hydrogen ions give acidic solutions their sour taste and their corrosive nature.
- When compounds present in water dissolve to form an acidic solution, we say the solution is acidic.

*Bases taste bitter. We often refer to bases as **alkaline**. When dissolved in water, bases release **hydroxyl ions**.*

- A hydroxyl ion ( $OH^-$ ) is a hydrogen atom that has combined with an oxygen atom and has one extra electron,.
- Hydroxyl ions give alkaline solutions their bitter taste, their slippery feel and their caustic nature.
- When compounds found in water dissolve to form a basic solution, we say the solution is alkaline.

You can test a substance to see if it is acidic or alkaline by using a material called litmus paper.

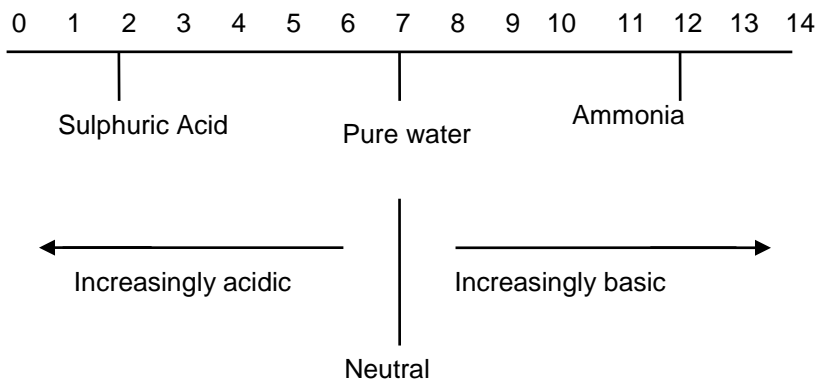
- Acids turn litmus paper red.
- Bases turn litmus paper blue.

If a water solution of an acid is combined in a specific proportion with a solution of a base, a chemical reaction will occur.

- The molecules of the base and the molecules of acid will break apart and reform into a new solution.
- The new solution will not be acidic nor will it be basic.
  - It will usually be a mixture of water and a salt.
- It will not be caustic or corrosive.
- This solution will be **neutral**.

## **THE pH SCALE**

The acidity or alkalinity of a substance is rated on a scale called the **pH scale**. The pH scale rates the acidity and alkalinity of a substance. The pH scale ranges in value from 0 (very acidic) to 14 (very basic). See Figure 1.



**FIGURE 1: The pH Scale**

- ◆ Pure water is considered **neutral**: it is neither acidic nor basic. Its pH, 7, is right in the middle.
- ◆ Any substance with a pH less than 7 down to 0 is acidic.
  - The smaller the number, the greater the acidity.
  - Sulphuric acid is a very strong acid, with a pH value of around 2.
- ◆ Any substance with a pH greater than 7 is considered basic.
  - The closer the number is to 14, the greater the alkalinity.
  - Ammonia is a strong base, with a pH of 12.

The following table shows the pH values of some of the substances you work with.

**TABLE 1: Table of Average pH Values**

Acid ↑	0	<b>Hydrochloric acid</b>	↑ ↓
	1		
	2	Lemon juice	
	3	Vinegar	
	4	Preserved fruit	
	5	Hair / Skin	
6	Coffee		
Neutral	7	<b>Distilled water</b>	
	8	Baking soda	
↑ Base	9	Soaps	
	10	Tri-sodium phosphate	
	11		
	12	Ammonia	
	13		
	14	<b>Lye</b>	

---

## ***EFFECT OF pH ON MEAT PROCESSING***

Living animals such as beef and pork usually have a pH of around 7.1, which is close to neutral. After an animal is slaughtered, the glycogen in the flesh starts changing to lactic acid. The pH value starts to drop as the meat becomes more acidic. Beef reaches its lowest pH value of 5.4 to 5.7 at 18-24 hours after slaughter. After the lowest pH level is reached, the pH starts to rise again slowly but steadily. By the time it reaches pH of 6.5, the meat is starting to decompose. Pork reaches its lowest pH value of 5.4 to 5.8 at 6-10 hours after slaughter.

The pH of a carcass results from factors such as genetics, pre-slaughter stress and post-slaughter handling. Pre-slaughter stress can be alleviated if the animals are unloaded quietly, have space to rest, are not too hot in the holding pens and the use of electric rods is kept to a minimum. The carcass must be cooled as quickly as possible after slaughter.

The pH of meat can affect its shelf life, tenderness, colour and taste. Meat at an ideal pH of between 5.3 and 5.7 is bright red. Meat with a lower pH becomes pale and soft. Meat with a higher pH becomes dark in colour and does not age well.

The pH of meat affects how well it retains water. Meat with a higher pH has better water retention properties. In the sausage making process, meat that can hold more water results in sausage that has a better flavour and appearance. However, because this type of sausage decomposes faster, it is only used for boiled sausage. Fresh sausage must be made from meat with a lower pH.

Ham must be cured in a brine or salt solution that has a pH of below 5.9. If the brine has an alkaline value when it is tested, this indicates that the ham has gone off or started to spoil. Packaged meat is prone to decomposition due to microorganisms if its pH is too high. Testing the pH of packaged meat is used to check that the meat is safe to sell. If the pH of the meat is above 5.9, then the meat is considered to be spoiled.

## ***ACIDITY AND FOOD PRESERVATION***

Microorganisms have unique pH values at which they grow most easily. Most grow well at a neutral pH of 7. Only a few bacteria grow well below pH 4. Molds can grow at a lower pH than most bacteria, so foods with natural acidity are more often spoiled by mold growth.

The tartness or sour taste of grapefruit, sauerkraut, yogurt, and pickles is the result of the acidity of these foods. Acidity plays a role in the preservation of food by preventing spoilage. Acidity occurs naturally in foods such as tomatoes, strawberries and lemons. It can also be produced by fermenting foods. For example, certain bacterial cultures added to foods result in food products such as yogurt and cheese. These foods keep better than pure milk. Acids can be added directly to foods, such as the lactic acid added to pickles.

Acidity controls spoilage by inhibiting the growth of microorganisms and by reducing the heat resistance of dangerous bacteria. Foods that are naturally acid can be preserved by heating to

temperatures just below boiling. Foods that are less acid need to be exposed to heat and pressure to destroy the spores of botulism.

### **CONCLUSION**

Acids are created when compounds react in a water solution to release hydrogen ions ( $H^+$ ). Bases are created when compounds react in a water solution to release hydroxyl ions ( $OH^-$ ).

The amount of hydrogen ions compared to the amount of hydroxyl ions is measured by the pH scale. A substance with a pH of 7 is neutral, with the same number of hydrogen ions as hydroxyl ions. Water is considered a neutral substance. Its pH is 7 on the scale.

An acidic substance ranges in pH from just below 7 to 0. A substance with a pH of 1 is very acidic. It has many free hydrogen ions. An alkaline substance ranges in pH from just above 7 to 14. A substance with a pH of 14 is very alkaline. It has many more hydroxyl ions than hydrogen ions.

Food preparation workers need to be aware of pH and its effects on food. They should also be aware of how pH determines the strength of detergents and disinfectants and follow directions properly when using them. The pH of a food helps determine how it should be processed and stored. Meat is tested for pH at different stages of processing for several reasons, including level of aging, amount of water retention and detection of spoilage.

**Answer the following questions on acids and bases. The answers are on the next page.**

1. If a substance turns blue litmus paper red, it is an \_\_\_\_\_ .
2. If a substance turns red litmus paper blue, it is a \_\_\_\_\_ .
3. An acid compound releases \_\_\_\_\_ ions when dissolved in water.
4. A basic compound releases \_\_\_\_\_ ions when dissolved in water.
5. A neutral solution can be made by mixing a \_\_\_\_\_ with a \_\_\_\_\_.
6. The pH scale ranges in value from 0 to \_\_\_\_\_.
7. Pure water is considered \_\_\_\_\_. It has a pH of \_\_\_\_\_ .
8. Any substance with a pH less than 7 is \_\_\_\_\_ .
9. Any substance with a pH greater than 7 is \_\_\_\_\_ .
10. The pH of meat determines how well it resists \_\_\_\_\_ .
11. Foods such as tomatoes and lemons are naturally more \_\_\_\_\_ .

**ANSWER PAGE**

1. acid
2. base
3. hydrogen
4. hydroxyl
5. an acid with a base
6. 14
7. neutral, 7
8. acidic
9. basic or alkaline
10. spoiling
11. acidic