

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

SCIENCE SKILLS
pH Scale

AN ACADEMIC SKILLS MANUAL
for
Industrial Maintenance Mechanic Trades

This trade group includes the following trades:
Boiler Maker,
Facilities Maintenance Mechanic & Technician, and
Industrial Mechanic (Millwright)

*Workplace Support Services Branch
Ontario Ministry of Education and Training*

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
Industrial Maintenance Mechanic Trades*

INTRODUCTION

Water in industrial systems often requires monitoring for the effects it may have on the materials in plumbing systems, on machine parts and before it leaves the facility for treatment in a community sewage treatment facility. Chemicals and minerals that are absorbed by water can cause corrosion of pipes, valves and machine parts. You will have to know how these substances will react in an industrial water system, and how to analyse and treat the water of an industrial facility.

In addition, chemicals frequently used in industrial settings must often be handled carefully because they can pose health and safety risks. These chemicals, if used properly, will do all those things successfully and safely but the ability to handle, store and use these products is important. You need to know more about these substances.

In this skills manual, we will look how some of the common compounds known as acids and bases found in industry are classified. This skills manual describes the following:

- ◆ Basic subdivisions of matter
- ◆ Acids and bases
- ◆ The pH scale

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. The first division of matter is into elements and compounds.

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 other substances.

- An element is made from one kind of *atom*.
- Examples include nitrogen, oxygen, hydrogen, carbon, iron, zinc, and aluminum.
- 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.

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

Acids taste sour, they often will react with metals to produce hydrogen gas. You can test a substance to see if it is acidic by using a material called litmus paper. Acids turn litmus paper red.

Bases taste bitter, turn litmus blue and feel slippery.. We often refer to bases as **alkaline**. Bases turn litmus paper blue.

Neutral solutions are neither acidic or basic. A neutral solution will not change litmus paper, nor will it damage other materials.

- If a water solution of an acid is combined in a specific proportion with a solution of a base, a chemical reaction will occur and the two solutions will reform into new molecular structures, creating 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.

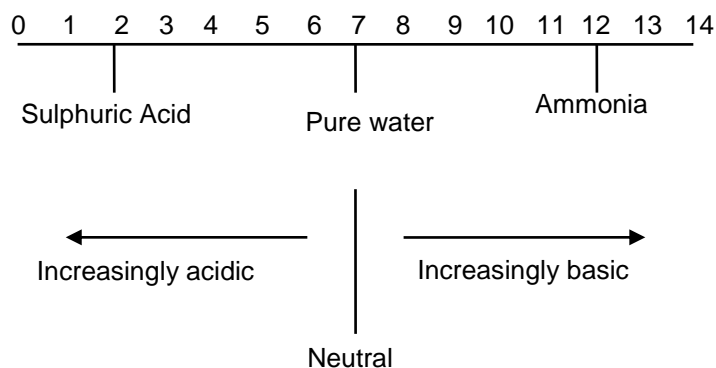


FIGURE 1: The pH Scale

- ◆ Pure water is considered ***neutral***: neither acidic or 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 of some common substances.

TABLE 1: Table of Average pH Values

Acid	0	Hydrochloric acid	
	1		muriatic acid
	2	Lemon juice	battery acid
	3	Vinegar	
	4	Rainwater	Colas
	5	Hair / Skin	Soda
	6	Urine	Coffee
Neutral	7	Distilled water	
	8	Blood	
	9	Soaps	
	10		
	11	Ammonia	
	12		TSP 1%
	13	Bleach	
Base	14	Lye	Drain cleaners

pH Is Important To Many Areas Of Your Trades.

Basic and acidic materials can affect the skin and building materials. It will be necessary to understand the nature of these chemicals in many areas of your work.

You will need a knowledge of acids and bases for water testing and for the proper chemical balancing of water systems

You will choose materials based on their reactivity.

- Metals such as iron, lead and copper can be damaged when exposed to caustic substances such as acids and bases.
- Cleaners and solvents are chosen for the way they react with dirt grease

You must practice safe handling and proper storage of highly corrosive and caustic substances.

CONCLUSION

Acidic solutions are created when compounds react in a water solution to release hydrogen ions (H^+). Alkaline solutions 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 ion. 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.

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 _____ with _____.
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. A solution with a pH of 5 is slightly _____ .
11. A solution with a pH of 9 is _____ .

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. acidic
11. alkaline