EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING
Revised for
FOR APPRENTICESHIP TRAINING

SCIENCE SKILLS
pH SCALE

AN ACADEMIC SKILLS MANUAL
for
The Construction Trades: Mechanical Systems

This trade group includes the following trades:
Electrician (Construction, Maintenance & Industrial),
Network Cabling Specialist, Plumber,
Refrigeration & Air Conditioning Mechanic,
Sprinkler & Fire Protection, and Steamfitter

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

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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 Construction Trades: Mechanical Systems

INTRODUCTION

In your trades, you work with solvents, glues and cleaners that contain chemicals known as acids and bases. Acids are corrosive and bases are caustic. Both will damage skin, clothes and other materials they come in contact with. These chemicals, which are termed acidic and alkaline (basic) require careful handling and proper storage.

Acids and bases are opposites of each other in many ways and you will need to know about them.

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

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.

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 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 (H^+) is a hydrogen atom that has lost its only electron.
- These free hydrogen ions give acidic solutions their sour taste and their corrosive nature.
  - Corrosion occurs when a gas or a liquid chemically attacks an exposed surface.
    - Rust is the most common form of corrosion.
    - Some materials resist corrosion naturally.
    - Some materials are treated to prevent corrosion, (e.g., by coating, painting, galvanizing, or anodizing).

    - Other materials are left untreated and the resulting corrosion forms a patina, or coating, which will protect the material.
- When compounds 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.
    - Caustic substances are chemical substances which will burn or destroy things, especially anything made of living cells.
    - Tri sodium phosphate solutions and drain cleaners are caustic substances.
- When compounds 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.

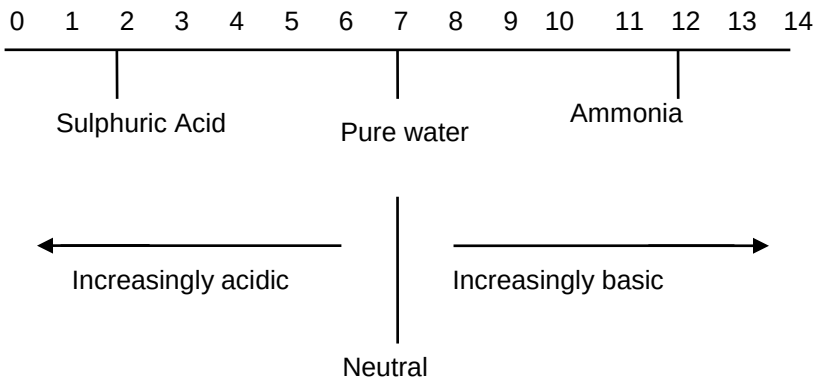

FIGURE 1: The pH Scale

- Pure water is considered ***neutral:*** 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**	muriatic acid
	1		battery acid
	2	Lemon juice	
		Vinegar	Colas
	3		
	4	Rainwater	Soda
	5	Hair / Skin	
			Coffee
	6	Urine	
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 materials in many areas of your work.

You will choose materials for installation based on their reactivity.

- Pipes and conduits made of PVC are non-reactive to acids and bases, whereas pipes made of metals such as lead or copper are reactive.
- Cleaners and solvents are chosen for the way they react with dirt and 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