St Ninian's High School



Chemistry Department



National 5 Chemistry

Unit 1: Chemical Changes & Structure

Section 1.5: Acids and Alkalis

Summary Notes

Name _

Learning Outcomes

After completing this section you should be able to :

- 1 state that the pH scale is a continuous range from less than 0 to above 14
- 2 state that acids have a pH value less than 7 and alkalis (soluble bases) have a pH value greater than 7
- 3 state that neutral substances like pure water have a pH value of 7
- 4 give examples of common acids and alkalis used in the laboratory and in the home
- 5 state that non-metal oxides which dissolve in water produce acidic solutions
- 6 explain that an acidic solution contains a greater concentration of H⁺(aq) ions than OH⁻ (aq) ions
- 7 explain that an alkaline solution has a greater concentration of $OH^{-}(aq)$ ions than $H^{+}(aq)$ ions
- 8 state that metal oxides which dissolve in water produce alkaline solutions
- 9 state that a neutral solution has an equal concentration of $H^+(aq)$ and $OH^-(aq)$ ions
- 10 explain that a small number of water molecules dissociate into an equal number of hydrogen and hydroxide ions
- 11 explain the effect of dilution in terms of the decreasing concentrations of hydrogen and hydroxide ions
- 12 state that acids and alkalis conduct electricity due to the presence of ions
- 13 state that water is a poor conductor of electricity due to a small number of ions.

The pH scale

The pH scale ranges from below 0 to above 14 and is used to measure the acidity or alkalinity of a solution. This can be done using a pH meter which gives an electronic reading or using an **indicator** which can change colour depending on the pH value. The colour can be matched on the pH colour chart to indicate the pH number.

Acidic solutions have a pH that is less than 7.

Alkaline solutions have a pH that is greater than 7.

Neutral solutions have a pH value of 7.

рН	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Type of Solution	, I	Acid Acid increasing acidity				Neutral	Alkali								

Non-metal oxides such as carbon dioxide, sulfur dioxide and nitrogen dioxide all dissolve to form acidic solutions. Food substances such as fruit juice are often acidic while cleaning substances such as toothpaste are often alkaline.

Acids

Common Acids

The four most common laboratory acids are listed in the table.

Name of Acid	Chemical Formula
hydrochloric acid	HCI
nitric acid	HNO ₃
Sulfuric acid	H ₂ SO ₄
ethanoic acid	CH₃COOH

All acidic solutions contain hydrogen.

Acid Conductivity

Acidic solutions contain non-metal elements and are formed when covalent substances such as sulfur dioxide dissolve. All acidic solutions will conduct electricity since they all contain the hydrogen ion, H⁺.

When acidic solutions are electrolysed (undergo electrolysis) hydrogen gas is produced at the negative electrode. During this process hydrogen ions gain electrons and form hydrogen atoms which then form molecules of hydrogen gas. The following ion electron equation shows this process:



Hydrogen ions Hydrogen gas

The hydrogen gas produced can be tested since it will burn with a pop.

Making Alkalis

Metal oxides are formed when a metal reacts with oxygen. Some **metal oxides** (soluble) will dissolve in water to form an alkaline solution. Soluble **metal hydroxides** will also dissolve forming **alkaline** solutions such as sodium hydroxide.

Insoluble metal oxides such as copper oxide will not affect the pH of water.

Some common alkalis are listed in the table below.

Name of Alkali	Chemical Formula	lons Present		
lithium hydroxide	LiOH	Li^{+} and OH^{-}		
sodium hydroxide	NaOH	Na ⁺ and OH ⁻		
Potassium hydroxide	кон	K^{+} and OH^{-}		
Calcium hydroxide	Ca(OH) ₂	Ca ²⁺ and OH ⁻		

All alkaline solutions contain hydroxide ions, OH⁻.

Summary So Far

- When an element reacts with oxygen an oxide is formed.
- Some non-metal oxides dissolve in water to form acidic solutions e.g. carbon, sulfur and nitrogen.
- Metal elements react with oxygen to produce metal oxides e.g. sodium and potassium.
- Soluble metal oxides and metal hydroxides dissolve in water to form alkaline solutions. Insoluble metal oxides and metal hydroxides do not effect the pH of water.

Hydrogen and Hydroxide lons

Explaining pH

Water is a neutral substance which mainly exists as water molecules. Water is an example of a non-metal oxide which is formed from hydrogen and oxygen. However, a very few water molecules break up (dissociate) to produce one hydrogen ion, H⁺, and one hydroxide ion, OH⁻.



Since water is mainly made of molecules and contains only a few ions it is a poor conductor of electricity. Since water contains an equal concentration of hydrogen and hydroxide ions - in other words it is neutral.

An acidic solution is one which contains a greater concentration of hydrogen ions compared to hydroxide ions while an alkaline solution will have a greater concentration of hydroxide ions compared to hydrogen ions.



Dilution

When a solution is diluted the concentration decreases. As an acid is diluted the pH increases as the concentration of hydrogen ions decreases. As an alkali is diluted the pH value decreases since the concentration of hydroxide ions decreases. Adding sufficient water to either an acidic or alkaline solution will produce a solution of pH value 7.

Topic 4 Summary Statements

- The pH scale is a continuous range from less than 0 to above 14.
- Acidic substances have a pH value less than 7 and alkaline substances have a pH value greater than 7
- Neutral substances like pure water have a pH value of 7.
- Common acids include:

Hydrochloric acid - HCl Sulfuric acid - H₂SO₄ Nitric acid - HNO₃ Ethanoic acid - CH₃COOH

Common alkalis used in the laboratory include:

Sodium hydroxide - NaOH Potassium hydroxide - KOH

- Non-metal oxides which dissolve in water produce acidic solutions.
- An acidic solution contains a greater concentration of $H^+(aq)$ ions than $OH^-(aq)$ ions.
- An alkaline solution has a greater concentration of $OH^{-}(aq)$ ions than $H^{+}(aq)$ ions.
- Metal oxides and metal hydroxides which dissolve in water produce alkaline solutions.
- A neutral solution has an equal concentration of $H^+(aq)$ and $OH^-(aq)$ ions.
- A small number of water molecules dissociate into an equal number of hydrogen and hydroxide ions.
- When a solution is diluted the concentration decreases.
- When an acidic solution is diluted the concentration of hydrogen ions decreases and the pH increases.
- When an alkaline solution is diluted the concentration of hydroxide ions decreases and the pH decreases.
- Acids and alkalis conduct electricity due to the presence of ions.
- When an acidic solution is electrolysed hydrogen gas will form at the negative electrode.
- Water is a poor conductor of electricity due to the low number of ions present.