



جامعة المستقبل  
AL MUSTAQBAL UNIVERSITY



**ALMUSTAQBAL UNIVERSITY**

**Department of Fuel and Energy  
Technologies Engineering**

**Analytical chemistry**

**First class / first term**

**Lecture Nine**

**By**

**Asst. lect. SAFA FALLAH**

## Lecture Nine

### What is Atomic Absorption Spectroscopy (AAS)

#### Introduction:

**Atomic absorption spectroscopy (AAS)** and atomic emission spectroscopy (AES) is a spectroanalytical procedure for the quantitative determination of chemical elements by free atoms in the gaseous state. Atomic absorption spectroscopy is based on absorption of light by free metallic ions. In analytical chemistry the technique is used for determining the concentration of a particular element (the analyte) in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution, or directly in solid samples via electrothermal vaporization,<sup>[1]</sup> and is used in pharmacology, biophysics, archaeology and toxicology research.

Atomic emission spectroscopy (AAS) was first used as an analytical technique, and the underlying principles were established in the second half of the 19th century by Robert Wilhelm Bunsen and Gustav Robert Kirchhoff, both professors at the University of Heidelberg, Germany.

The modern form of AAS was largely developed during the 1950s by a team of Australian chemists. They were led by Sir Alan Walsh at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Division of Chemical Physics, in Melbourne, Australia.<sup>[3][4]</sup>

Atomic absorption spectrometry has many uses in different areas of chemistry such as clinical analysis of metals in biological fluids and tissues such as whole blood, plasma, urine, saliva, brain tissue, liver, hair, muscle tissue. Atomic absorption spectrometry can be used in qualitative and quantitative analysis.

#### What are AAS used for?

Atomic absorption spectrometry (AAS) is an easy, high-throughput, and inexpensive technology used primarily to analyze elements in solution. As such, AAS is used in food and beverage, water, clinical research, and pharmaceutical analysis.

#### How does an AAS work?

Atomic absorption spectrometry (AAS) detects elements in either liquid or solid samples through the application of characteristic wavelengths of electromagnetic radiation from a light source.

## Lecture Nine

### What does an AAS measure?

What is atomic absorption spectroscopy? AAS is an analytical technique used to determine the concentration of metal atoms/ions in a sample. Metals make up around 75% of the earth's chemical elements. In some cases, metal content in a material is desirable, but metals can also be contaminants (poisons).

### What is atomic adsorption spectroscopy?

Atomic adsorption spectroscopy (AAS) is used to measure the concentration of metallic elements in different materials. As an analytical technique, it uses electromagnetic wavelengths, coming from a light source. Specific elements will absorb these specific wavelengths differently, giving a picture of what concentrations of a specific element there is in the material being tested.

### What is the pH meter?

A pH meter is an instrument used to measure hydrogen ion activity in solutions - in other words, this instrument measures acidity/alkalinity of a solution. The degree of hydrogen ion activity is ultimately expressed as pH level, which generally ranges from 1 to 14.

### How does a pH meter work?

A pH meter is consisted of three different parts: an internal electrode, a reference electrode, and a high input impedance meter. Glass probe often contains the two electrodes -- internal electrode and reference electrode. The internal electrode is a Silver wire covered with Silver Chloride (Ag/AgCl wire), and reference electrode is often made up of the same materials. Inside the probe is a buffer solution at pH of 7. Measured pH is the difference in  $[H^+]$  between the reference buffer inside the probe and the sample solution.

The pH measurements are made by comparing the pH reading of a sample solution to that of a reference solution with defined pH, such as buffers. Therefore, it is important to calibrate the instrument with appropriate buffer solutions before making any measurements. The figure on the right is a

## Lecture Nine

simple depiction of a glass electrode used with pH meters ([Source: Electrochemistry Theory and Practice, Hach](#)).

[For more information on calibration, visit the calibration page.](#)

characteristics of the element under test.

### What does a pH meter measure?

An electronic pH meter is used to obtain more accurate pH measurements. A pH meter is an instrument used to measure hydrogen ion activity in solutions - in other words, this instrument measures acidity/alkalinity of a solution. The degree of hydrogen ion activity is ultimately expressed as pH level, which generally ranges from 1 to 14.

This pH measurement is directly related to the ratio of hydrogen ion concentration and hydroxyl ion concentration ( $[H^+]$  and  $[OH^-]$ , respectively). The general breakdown of pH levels is listed below:

- Neutral solution:  $pH = 7$
- Acidic solution:  $pH < 7$
- Basic solution:  $pH > 7$

A neutral solution will show a pH of 7 due to the equal activities of hydrogen and hydroxide ions. Acidic solutions exhibit pH readings below 7 (higher hydrogen ion activity compared to hydroxide ion activity), and basic (or alkaline) solutions exhibit pH levels above 7 (hydroxide ion activity is greater than that of hydrogen ion).

### **Applications**

pH meters are widely used in the following industries:

- Food & beverage
- Pharmaceutical
- Oil & gas
- Agriculture
- Water treatment plant

## **Lecture Nine**

While this is not an exhaustive list of industries utilizing pH meters, it is clear that pH meter is an essential component of science and that it has a big impact on our lives. For example, they can be used to measure acidity levels in wastewater, which is a vital component of wastewater treatment process. They are used to analyze the exact pH value of food grade products and chemical products to ensure safety and quality, or they can be used to evaluate acidity/alkalinity of drugs in pharmaceutical and biotechnology industries.

### **What is chromatography?**

Chromatography is a technique carried out in laboratories to separate components into simple or complex mixtures. There are many different types of chromatography, ranging from paper chromatography and thin layer chromatography to gas chromatography.

Although there are many forms of chromatography, they all operate on the same principle. All the different types feature a stationary phase – usually a solid – and something to carry the complex mixtures through the stationary phase, called the mobile phase, which is usually a gas or a liquid.

The different types of chromatography can be categorized depending on the type of mobile phase used. If the mobile phase is liquid, the technique falls under the category of liquid chromatography. Likewise, if the mobile phase is gas, the technique falls under the category of gas chromatography.

### **How does chromatography work?**

All types of chromatography work upon the same basic principle. As the names suggest, the mobile phase is ‘mobile’ and flows through a ‘stationary’ stationary phase. As the moving mobile phase carries the mixture through the stationary phase, the individual components in the mixture are partitioned between the stationary and mobile phases. This process allows the separation of components in the mixture because different components in the mixture have different interactions with the stationary and mobile phases.

In practice, this means that components in the mixture that ‘hold on more tightly’ to the stationary phase, stay for longer on the stationary phase. This means that they are separated from other components in the mixture that do not ‘hold on as tightly’ to the stationary phase. This is the basis of chromatography as a separation technique.

## Lecture Nine

### What is a wavelength?

Wavelength is the distance between identical points (adjacent crests) in the adjacent cycles of a waveform signal propagated in space or along a wire. In [wireless](#) systems, this length is usually specified in meters (m), centimeters (cm) or millimeters (mm). In the case of infrared (IR), visible light, ultraviolet (UV), and gamma radiation ( $\gamma$ ), the wavelength is more often specified in nanometers (nm), which are units of  $10^{-9}$  m, or angstroms ( $\text{\AA}$ ), which are units of  $10^{-10}$  m. The wavelength of light is defined as “**The distance between the two successive crests or troughs of the light wave**”. It is denoted by the Greek letter lambda ( $\lambda$ ). Therefore, the distance between either one crest or trough of one wave and the next wave is known as wavelength.

Wavelength is inversely related to frequency, which refers to the number of wave cycles per second. The higher the frequency of the signal, the shorter the wavelength.

In [physics](#) and [mathematics](#), **wavelength** or **spatial period** of a [wave](#) or [periodic function](#) is the distance over which the wave's shape repeats.<sup>[1][2]</sup> In other words, it is the distance between consecutive corresponding points of the same *phase* on the wave, such as two adjacent crests, troughs, or [zero crossings](#). Wavelength is a characteristic of both traveling waves and [standing waves](#), as well as other spatial wave patterns.<sup>[3][4]</sup> The [inverse](#) of the wavelength is called the *spatial frequency*. Wavelength is commonly designated by the [Greek letter lambda](#) ( $\lambda$ ). The term "wavelength" is also sometimes applied to [modulated](#) waves, and to the sinusoidal [envelopes](#) of modulated waves or waves formed by [interference](#) of several sinusoids.

Assuming a [sinusoidal wave](#) moving at a fixed wave speed, wavelength is inversely proportional to the [frequency](#) of the wave: waves with higher frequencies have shorter wavelengths, and lower frequencies have longer wavelengths.

Wavelength depends on the medium (for example, vacuum, air, or water) that a wave travels through. Examples of waves are [sound](#)

## Lecture Nine

[waves](#), [light](#), [water waves](#) and periodic electrical signals in a [conductor](#). A [sound](#) wave is a variation in air [pressure](#), while in [light](#) and other [electromagnetic radiation](#) the strength of the [electric](#) and the [magnetic field](#) vary. Water waves are variations in the height of a body of water. In a crystal [lattice vibration](#), atomic positions vary.

The range of wavelengths or frequencies for wave phenomena is called a [spectrum](#). The name originated with the [visible light spectrum](#) but now can be applied to the entire [electromagnetic spectrum](#) as well as to a [sound spectrum](#) or [vibration spectrum](#).

**Wave length Words:** Related to wavelength According to the algorithm that drives this word similarity engine, the top 5 related words for "wavelength" are: frequency, amplitude, electromagnetic spectrum, distance, and wave.