FLAME PHOTOMETER

EP902

FLAME PHOTOMETER

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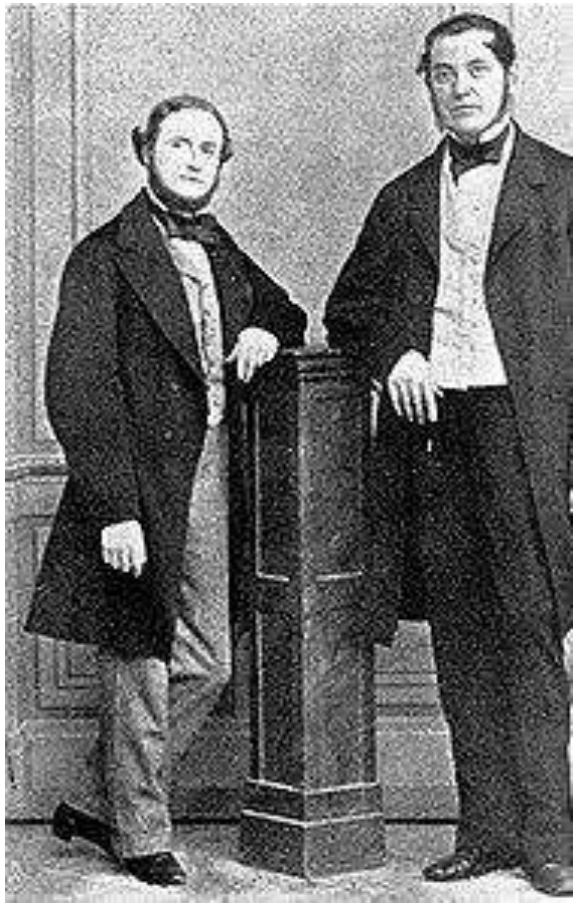


Gustav Kirchhoff (left) and Robert Bunsen (right)

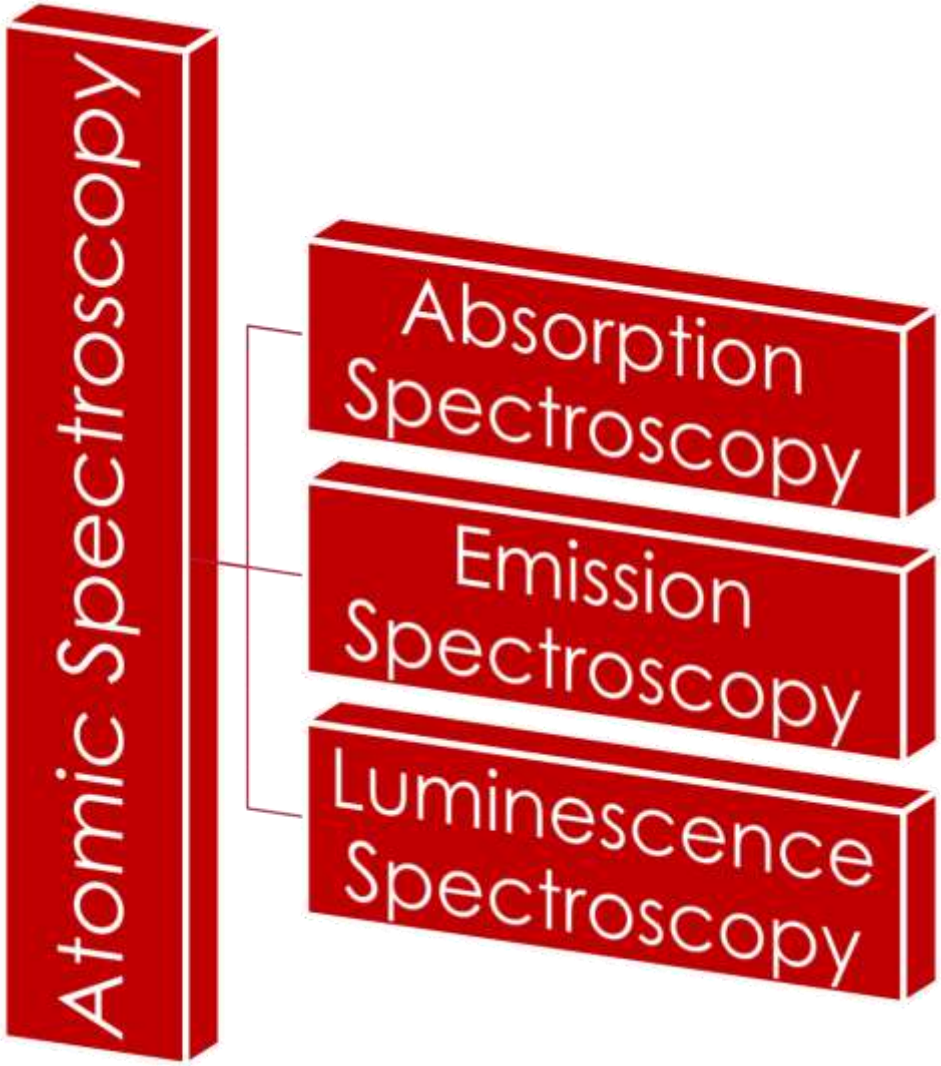
Atomic Spectroscopy:

"The **determination of elemental composition** by its electromagnetic or mass spectrum."

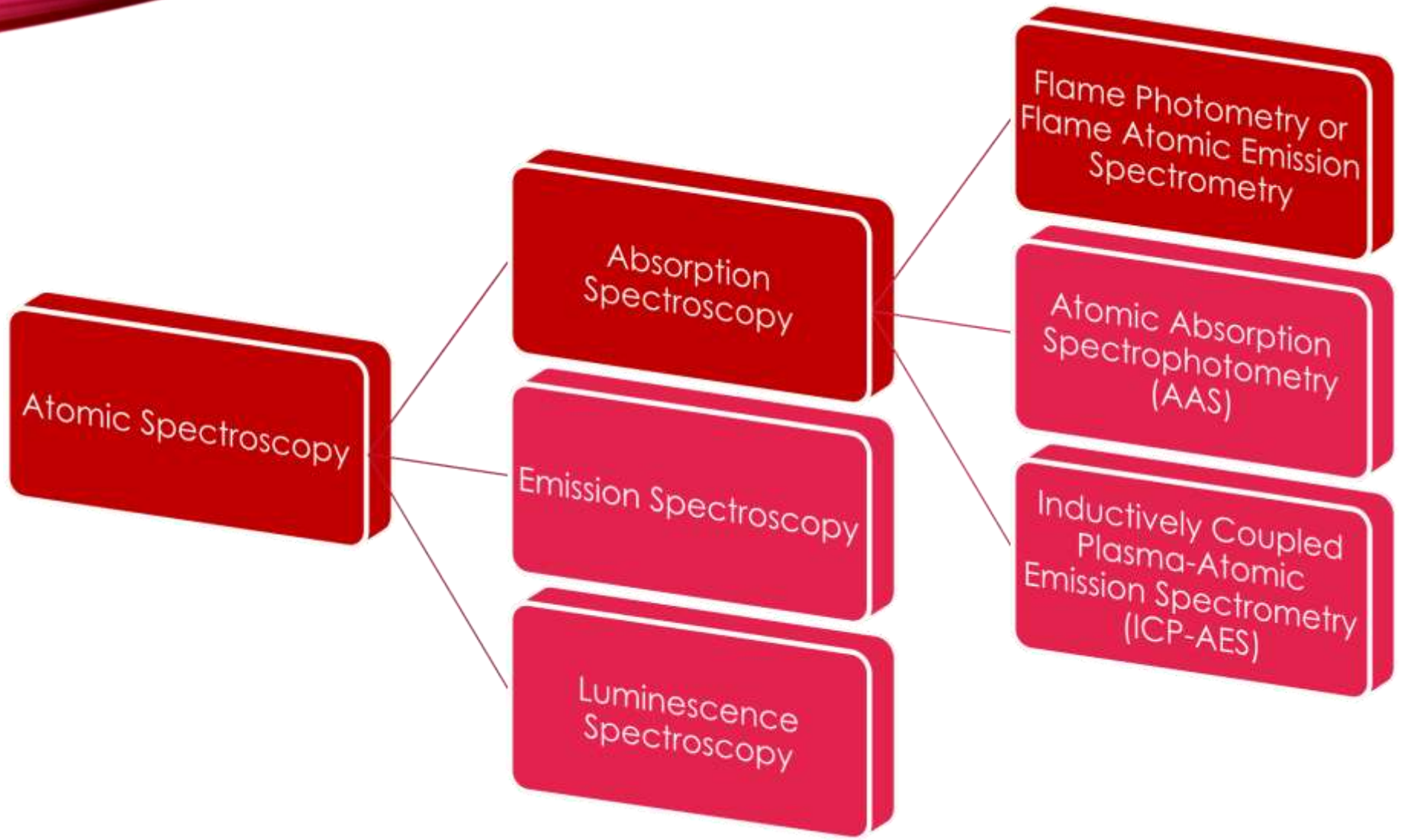
Atomic Spectroscopy is assumed to be the oldest instrumental method for the determination of elements.

These techniques are introduced in the mid of 19th Century, when Bunsen and Kirchhoff showed that the radiation emitted from the flames depends on the characteristic element present in the flame.

TYPES OF ATOMIC SPECTROSCOPY



TYPES OF ATOMIC SPECTROSCOPY



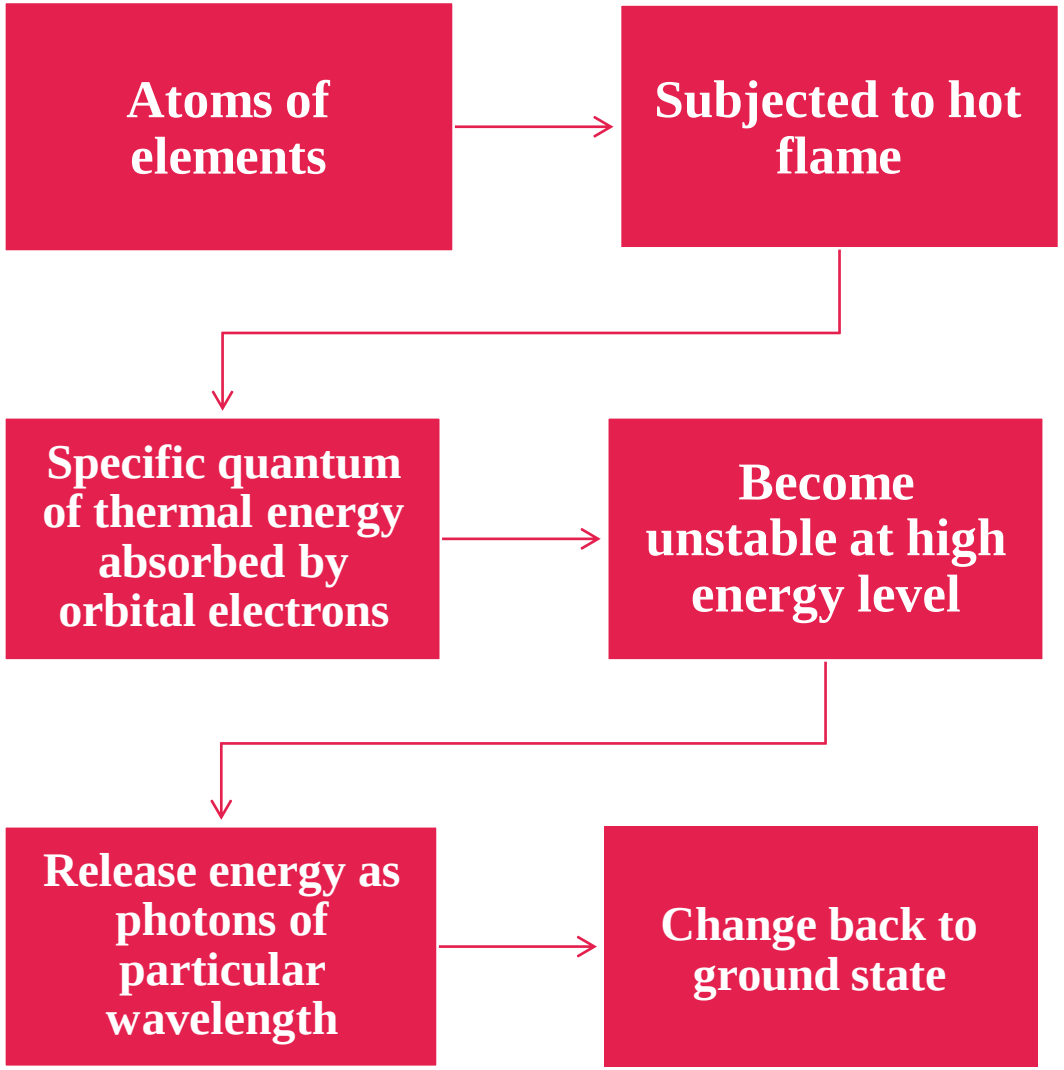
FLAME PHOTOMETER

Flame Photometry or Flame Atomic Emission Spectrometry is a branch of spectroscopy in which the species examined in the spectrometer are in the form of atoms.

Flame Photometer: "An instrument used in inorganic chemical analysis to determine the concentration of certain metal ions among them sodium, potassium, calcium and lithium."

- Flame Photometry is based on measurement of **intensity of the light** emitted when a metal is introduced into flame.
- The **wavelength of color** tells us what the element is (qualitative).
- The color's intensity tells us how much of the **element present** (quantitative).

PRINCIPLE



The **basic principle** upon which Atomic Spectroscopy works is based on the fact that **"Matter absorbs light at the same wavelength at which it emits light."**

- When a metal salt solution is burned, the metal provides a colored flame and each metal ion gives a different colored flame.
- Flame tests, therefore, can be used to test for the absence or presence of a metal ion.

• Parts of a Flame Photometer

➢ **Source of Flame**

A **burner** that provides flame and can be maintained in a constant form and at a constant temperature.

➢ **Nebulizer and Mixing Chamber**

Helps to transport the homogeneous solution of the substance into the flame at a steady rate.

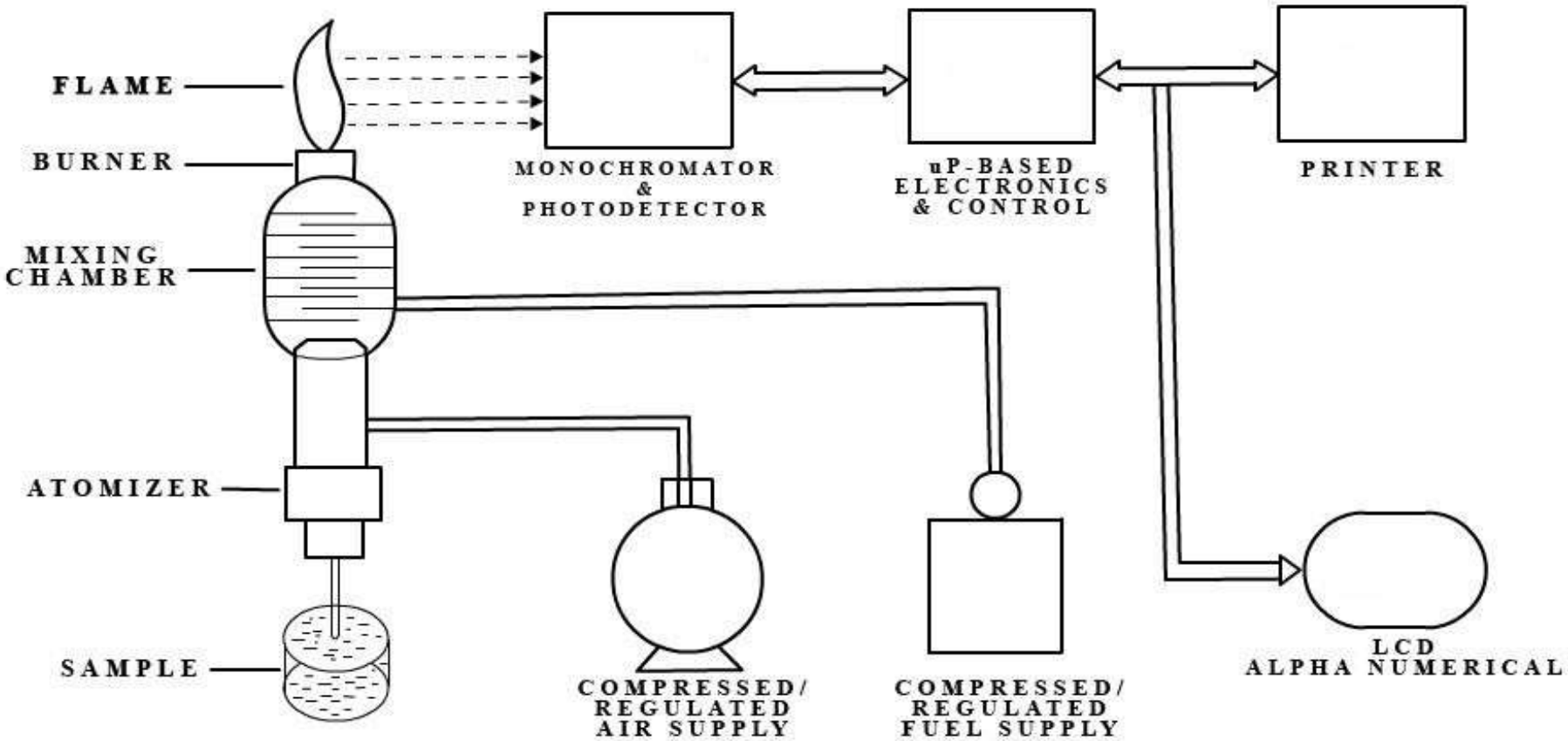
➢ **Optical System (Optical Filter)**

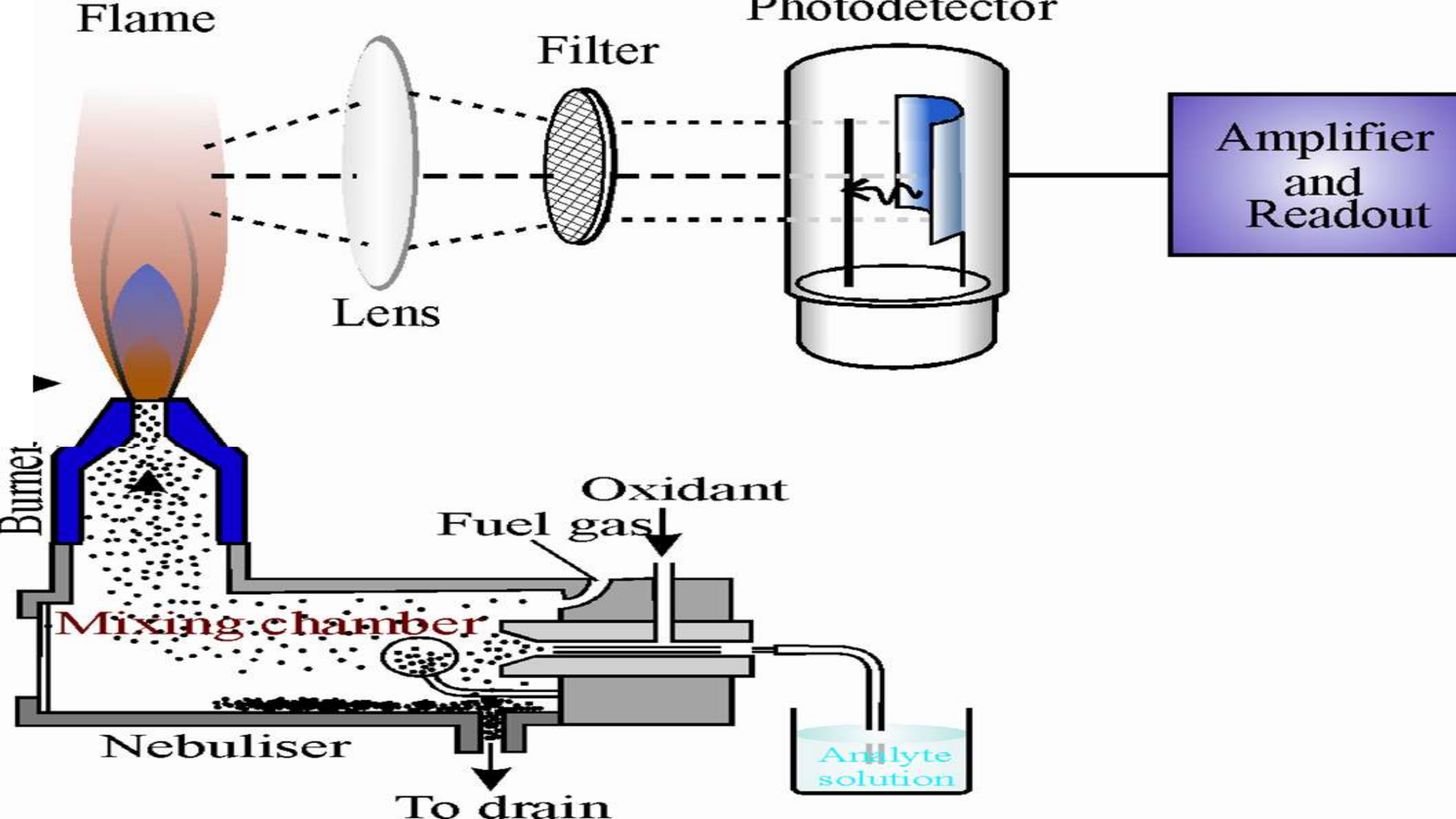
The optical system comprises three parts: **convex mirror**, **lens** and **filter**. The convex mirror helps to transmit light emitted from the atoms and focus the emissions to the lens. The convex lens help to focus the light on a point called slit. The reflections from the mirror pass through the slit and reach the filters. This will isolate the wavelength to be measured from that of any other extraneous emissions. Hence it acts as interference type color filters.

➢ **Photo Detector**

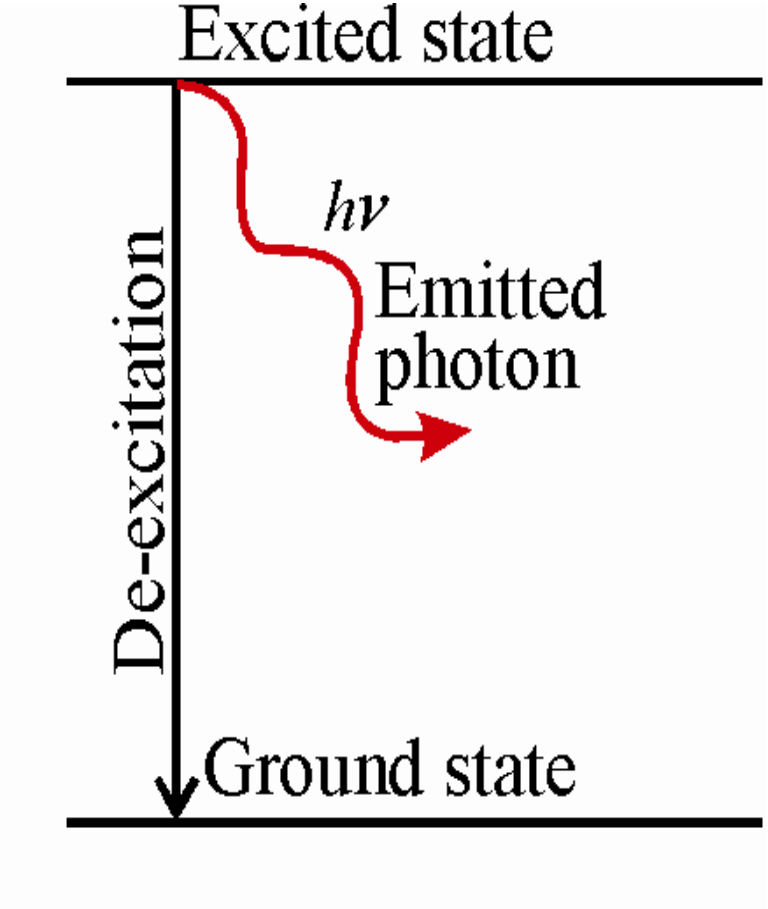
Detect the emitted light and measure the intensity of radiation emitted by the flame. That is, the emitted radiation is converted to an electrical signal with the help of photo detector. The produced electrical signals are directly proportional to the intensity of light.

INSTRUMENTATION




Flame
Filter
Photodetector
Lens
Amplifier and Readout
Burner
Oxidant
Fuel gas
Mixing chamber
Nebuliser
Analyte solution
To drain

MECHANISM



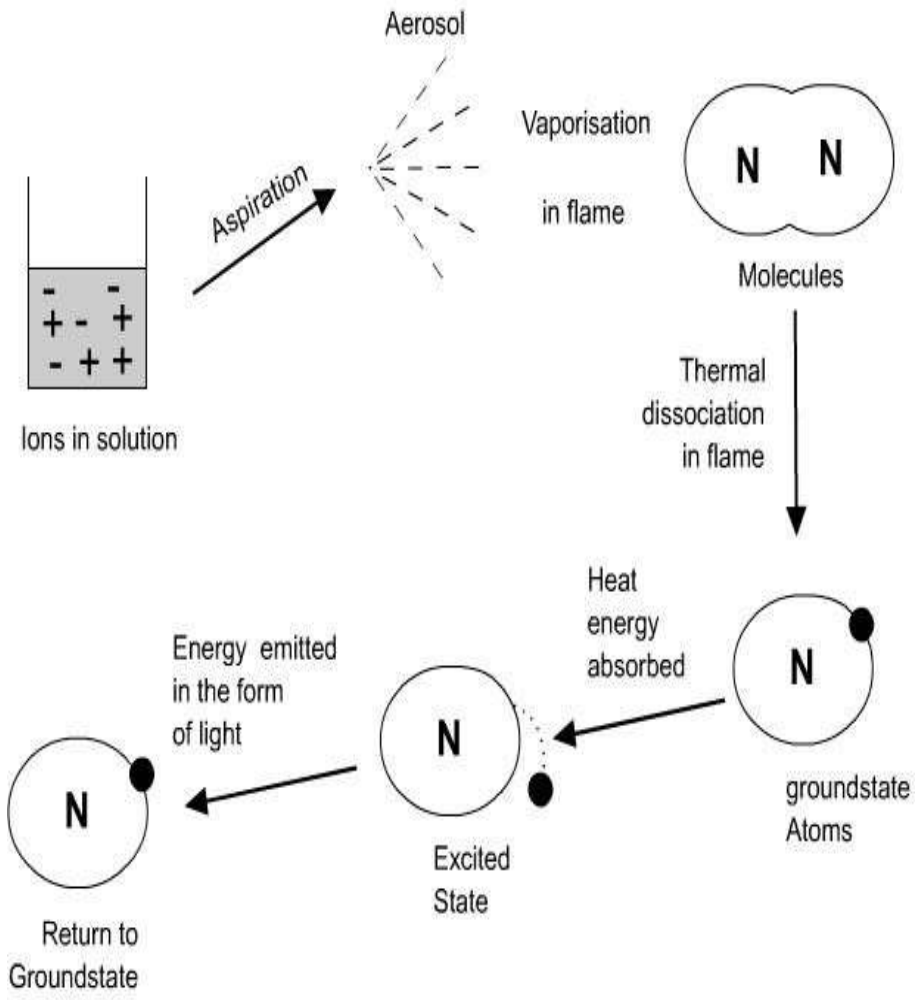
Nebulization

"A dispenser that turns a liquid into a fine mist called nebulizer (such as perfume)."

The solution of the substance to be analyzed is first aspirated into the burner, which is then dispersed into the flame as fine spray particles.

A brief overview of the process

- The solvent is first evaporated leaving fine divided solid particles.
- This solid particles move towards the flame, where the gaseous atoms and ions are produced.
- The ions absorb the energy from the flame and excited to high energy levels.
- When the atoms return to the ground state radiation of the characteristic element is emitted.
- The intensity of emitted light is related to the concentration of the element.



In the flame

Flame photometry employs a variety of fuels mainly air, oxygen or nitrous oxide (N_2O) as oxidant. The temperature of the flame depends on fuel-oxidant ratio. The intensity of the light emitted could be described by the Scheibe-Lomakin Equation

$$\boldsymbol{I = k \times c^n}$$

Where,

$\boldsymbol{I}$ = Intensity of emitted light

$\boldsymbol{c}$ = The concentration of the element

$\boldsymbol{k}$ = Constant of proportionality

$\boldsymbol{n}$~1 (At the linear part of the calibration curve)

Then,

$$\boldsymbol{I = k \times c}$$

That is the intensity of emitted light is directly related to the concentration of the sample.

MECHANISM

Name of the element	Emitted wavelength range (nm)	Observed color of the flame
Potassium (K)	766	Violet 
Lithium (Li)	670	Red 
Calcium (Ca)	622	Orange 
Sodium (Na)	589	Yellow 
Barium (Ba)	554	Lime green 

APPLICATIONS

Flame photometer has both quantitative and qualitative applications.

- Flame photometer with monochromators emits radiations of characteristic wavelengths which help to detect the presence of a particular metal in the sample. This help to determine the availability of alkali and alkaline earth metals which are critical for soil cultivation.
- In agriculture, the fertilizer requirement of the soil is analyzed by flame test analysis of the soil.
- In clinical field, Na+ and K+ ions in body fluids, muscles and heart can be determined by diluting the blood serum and aspiration into the flame.
- Analysis of soft drinks, fruit juices and alcoholic beverages can also be analyzed by using flame photometry.

ADVANTAGES

- Simple quantitative analytical test based on the flame analysis.
- Inexpensive.
- The determination of elements such as alkali and alkaline earth metals is performed easily with most reliable and convenient methods.
- Quite, convenient, selective and sensitive to even parts per million (ppm) to parts per billion (ppb) range.

DISADVANTAGES

- The concentration of the metal ion in the solution cannot be measured accurately.
- A standard solution with known molarities is required for determining the concentration of the ions which will corresponds to the emission spectra.
- It is difficult to obtain the accurate results of ions with higher concentration.
- The information about the molecular structure of the compound present in the sample solution cannot be determined.
- The elements such as carbon, hydrogen and halides cannot be detected due to its non-radiating nature.

THANK YOU FOR YOUR ATTENTION