Flame Photometry-Principle, interferences, instrumentation and applications

Atomic Emission Spectroscopy

Or Flame Photometry.

- To detect the Concentration of Element in sample or to detect which type of element present in sample we Use Atomic Emission Spectroscopy

1. Which Element & Conc. of Element-

- 2. sample like food product (ready-made) Cold Drink, food, Noodle in which we Check the Concentration of Element like Alkali Metals (Na, Li, k) etc. Alkali — Earth Metal. (Ca, Ba, Mg)

→ We Check the Concentration of Element → Alkali Metals.
↓ Alkali Earth Metal.

- First of all we prepared solution of the sample & to analyze it we placed it on Instrument.

3. Sample → Solution (To, Analyze) → Placed on Instrument-

- If our sample is in solid form then we mix the solvent in solid sample & form solution. Or Via Laser Ablation method We Can Analyse the sample.

4. If Solid Sample → Then Mixed with Solvent → & form Solution.

Or

5. – Sample solution is Inserted into the first Chamber of instrument i.e Nebulizer.

6. – In Nebulizer Sample is Converted into Tiny droplets.

7. – With the help of flow of Inert Gas we can shift this Tiny droplet to flame.

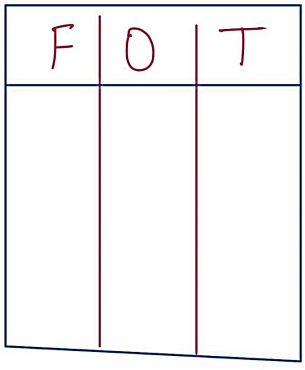
8. – To, Maintain the Temprature of flame we provide Constant supply of fuel & Oxidants. (It is Very Necessary to Maintain flame Temperature)

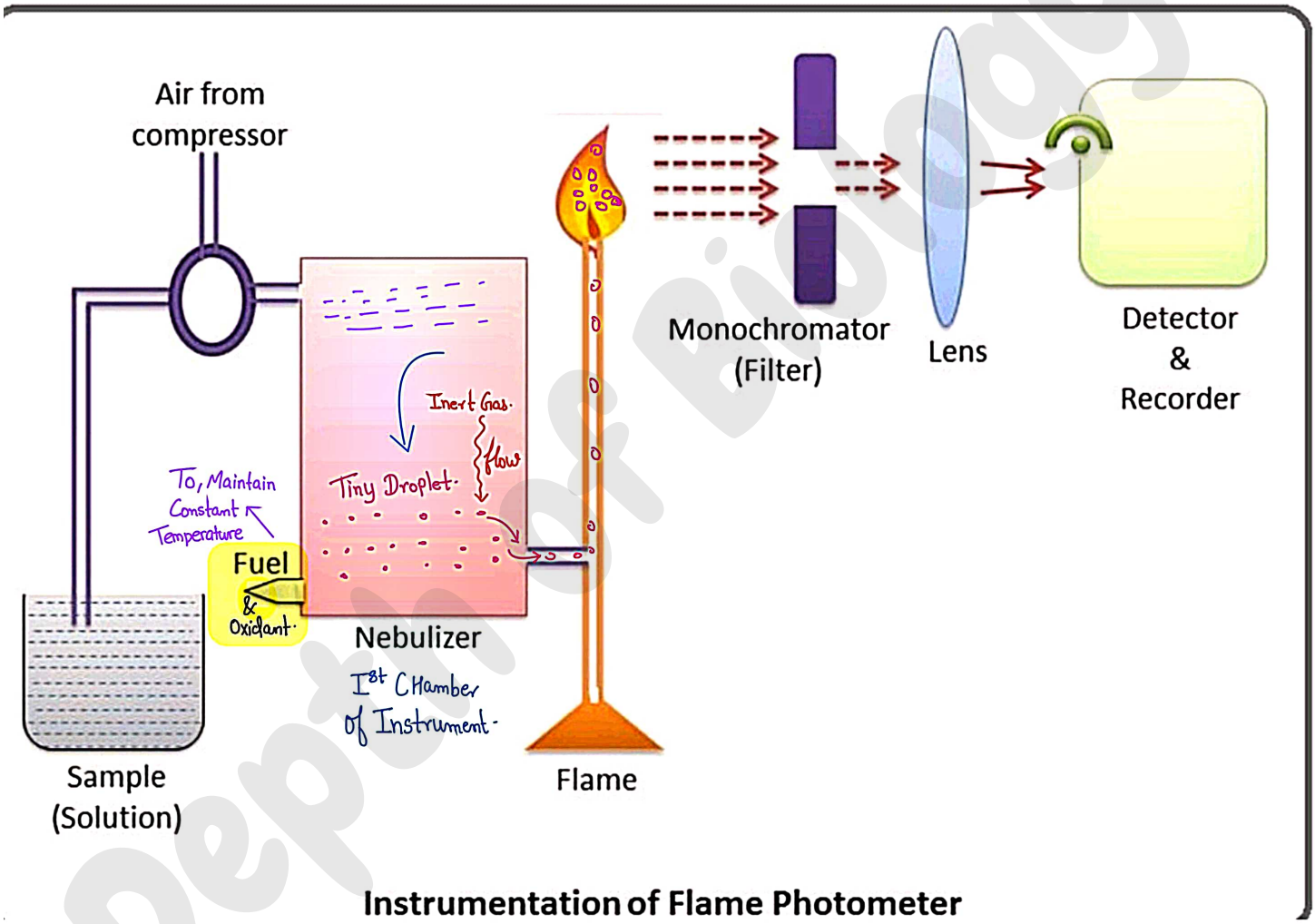
9. – Different fuel & Oridants are supply to acheive different Temprature of flame.

FUEL OXIDANT MIXTURE

Temprature

1. Natural gas-Air- 1700
2. Propane-Air- 1800
3. Hydrogen - Air- 2000
4. Hydrogen - Oxygen- 2650



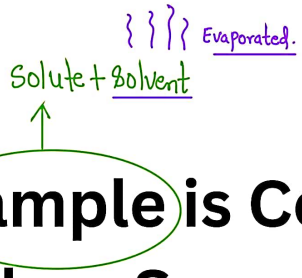


Instrumentation of Flame Photometer

5.Acetylene - Air - 2300
6.Acetylene - Oxygen - 3200
7.Acetylene - Nitrous Oxide- 2700
8.Cyanogen -Oxygen- 4800

When Tiny droplet reaches to flame it undergoes into different or Various Steps.

1. Desolvation
2.Vaporisation
3.Atomization.
4. Excitation.
5. Emission



- **Desolvation - Our sample is Consist of sample & Solvent, when Sample reaches into flame via flow of Inert Gas then solvent is evaporated**

Sample Molecule (solute) ⟶ Converted into Gas (Due to High Temperature of Flame).

- **Vaporisation**-Now, after evaporation of solvent, Sample molecule Converted into gas form due to High Temprature of flame

Gas ⟶ Atom (Via Flame/Atomizer).

- **Atomization**-Now, after Conversion of sample into gas form (or produce atoms) this step is known as Atomization & production of Atoms takes place with the help of flame
- So, flame is known as Atomizer.

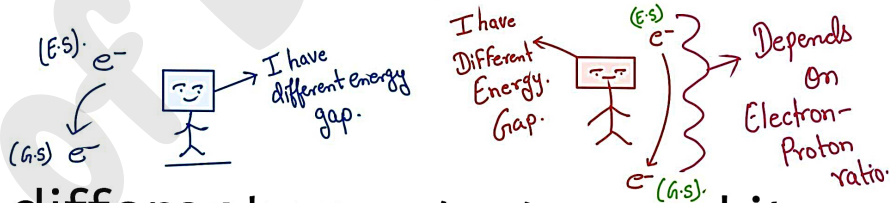
Atoms Use Thermal Energy of Flame ⟶ & Excite into Higher State.

- **Excitation**-Atoms Use Thermal energy of flame or We Can say Atoms absorb Thermal energy of flame & excite into high energy state.

- Energy absorbed by electron of atoms & excited from ground state to excited state, this step is known as excitation

- Emission - Atoms are usually unstable at Higher energy state, it again get back to lower energy state via emit /release energy & this Step is Called emission.

- # Here we Use Flame for Providing energy to atom, so this technique is called flame atomic emission spectroscopy Or flame Photometry



- Each atom has different energy gap and it depends on electron- proton ratio
- Each atom have different electron proton ratio
- Due to difference in energy gap in different atom the (excited electron) comes into ground state & Show different radiation because energy gap is different & that's why each atom show a unique spectrum

- Monochromator Transmit a specific wavelength light & that light falls into detector or Photomultiplier & then light/signal multiply & Spectrum is formed on Computer Screen

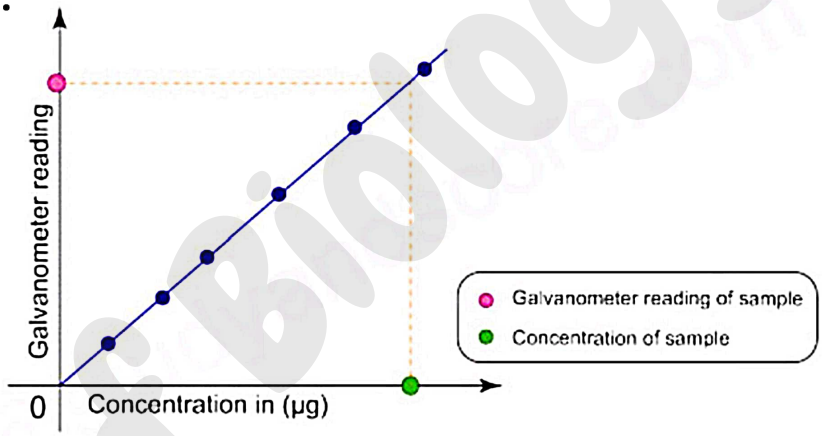
- Different spectrum is formed of different atom.

- Flame Colour changes on the basis of which type of element is present in flame..

Name of element	Emitted wavelength (nm) & colour
Potassium (K)	766 - violet
Lithium (Li)	670- red
Calcium (Ca)	622 - orange
Sodium (Na)	589 - yellow
Barium (Ba)	554 - lime green

Quantitative Analysis

- We Use Known sample (means we know which element is present in sample and at what Concentration).



FLAME PHOTOMETER: GRAPH

- Here, We Plot a Calibration Curve by (changing the conc. of Sample & then we check Transmited Light & then we put a unknown sample with unkown Concentration of sample/element
- Then, we Check Transmittance of Light.
- Then we Compare / or match the Value of Unknown sample & Calibrated Curve Then we can easily Identify the element or Concentration of element.

Atomic absorption spectroscopy- Principle, interferences, instrumentation and applications

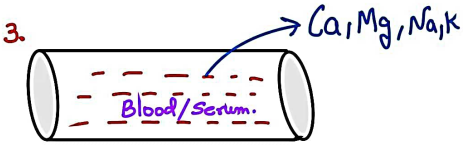
Nepheloturbidometry- Principle, instrumentation and applications

Atomic Absorption Spectroscopy

- Atomic Absorbtion spectroscopy is Used to determine element or Concentration of element present in sample. 1. Element or Conc. of Element

- Example- we can determine the element & it's Concentration in 2. Marketed Packed foods. (or food Industry).

- To determine the presence or Concentration of Ca, Mg, Na, K in serum/blood



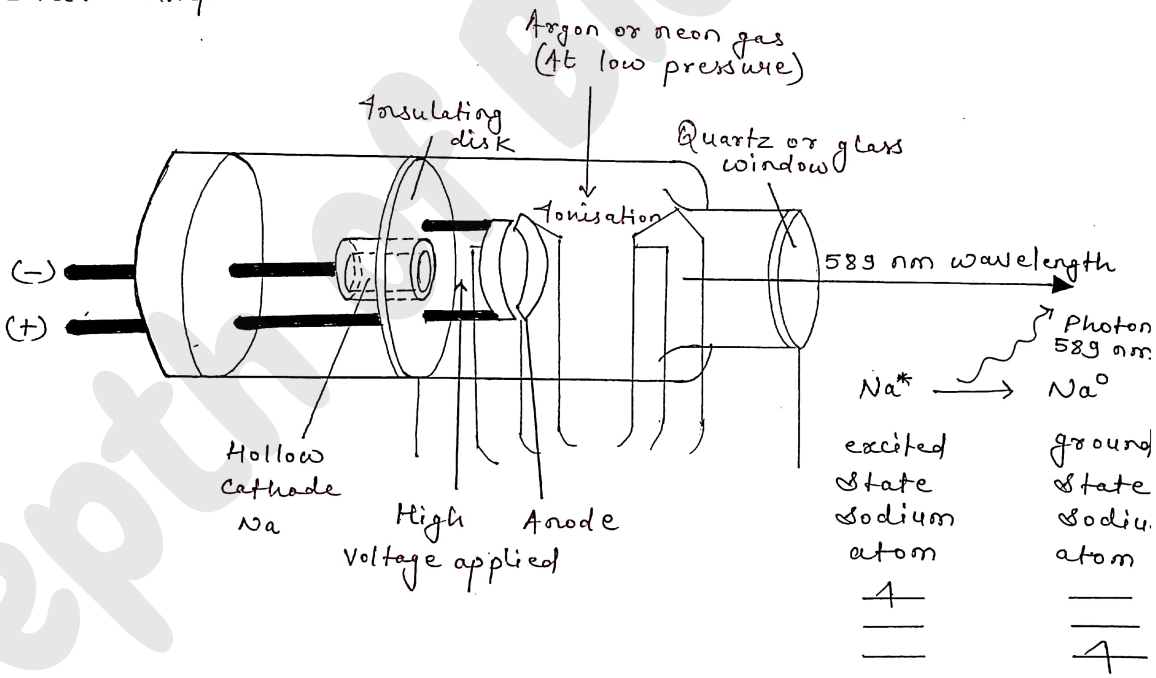
- To determine the Concentration of lead in petrol

- The first & Main Component of AAS is Radiation Source
- Radiation source are of different types
- (1) Electrode-less Discharge Lamps (EDLs).
- (ii) Hollow Cathode Lamps
- (iii) Deuterium Lamps.

INSTRUMENTATION – ATOMIC ABSORPTION SPECTROSCOPY

Types of Radiation Source

1. Electrode-less Discharge Lamps (EDLs)
2. Hollow cathode Lamps
3. Deuterium Lamps



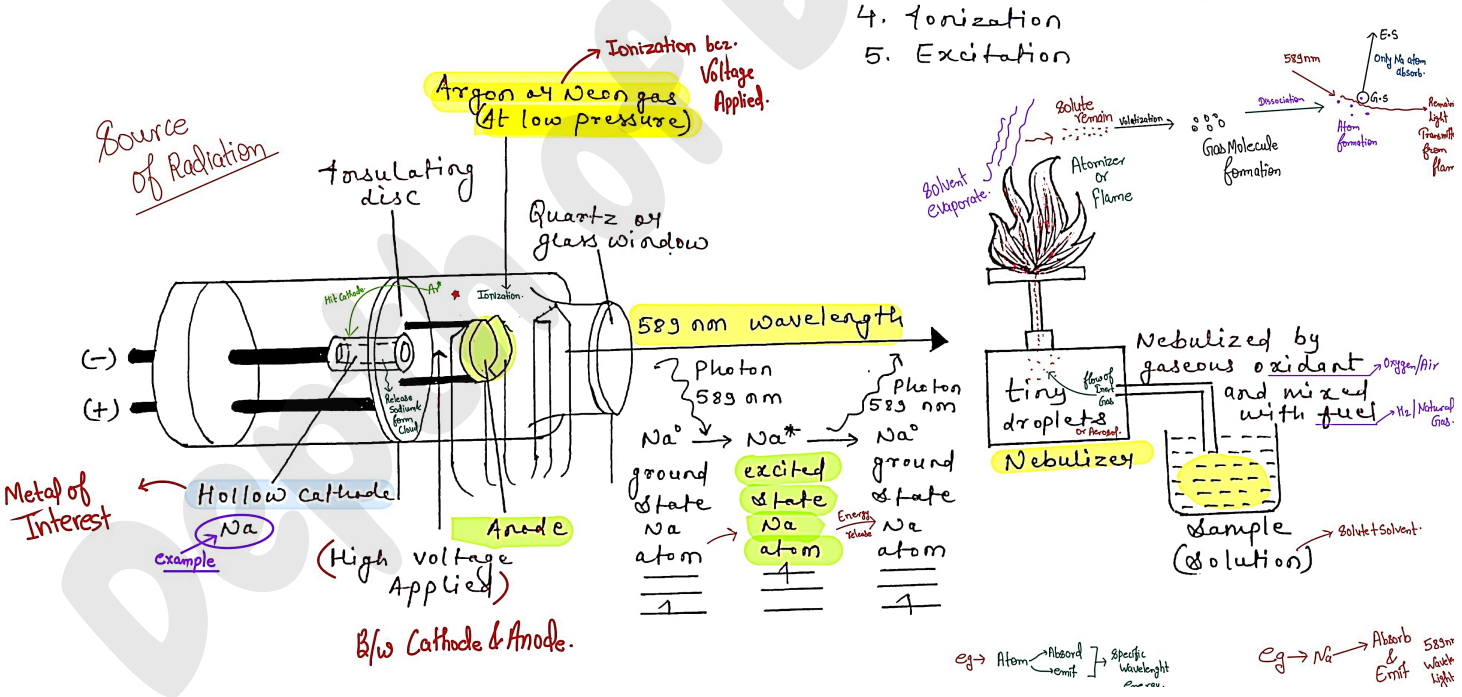
Instrumentation – Atomic Absorption Spectroscopy

Types of **Radiation Source** :–

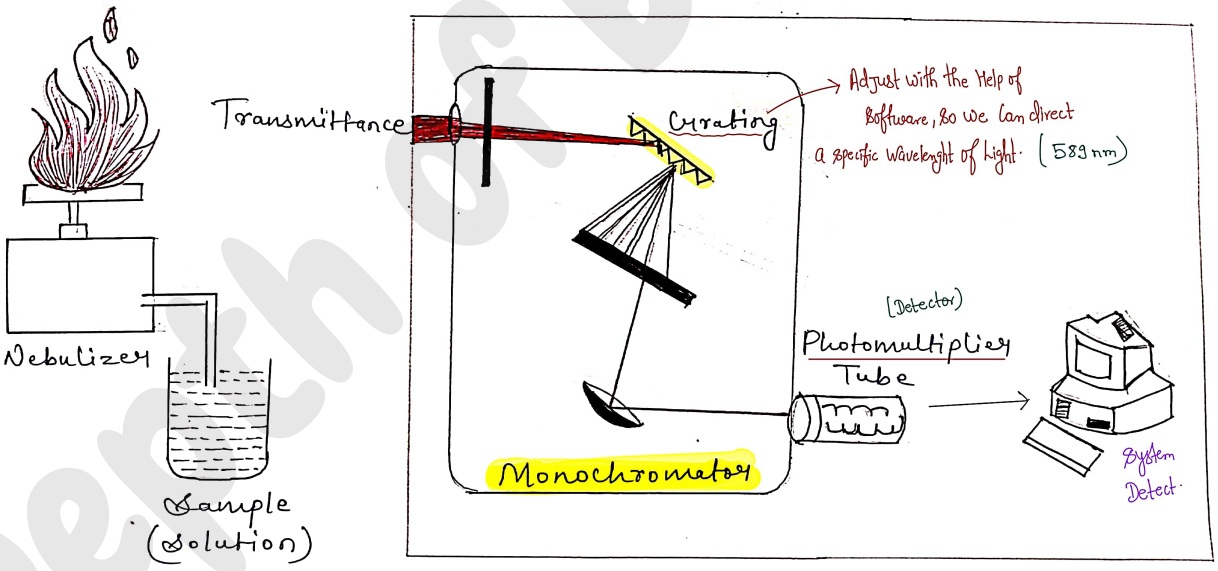
1. Electrode-less Discharge Lamps (EDLs)
2. **Hollow Cathode Lamps**
3. Deuterium Lamps

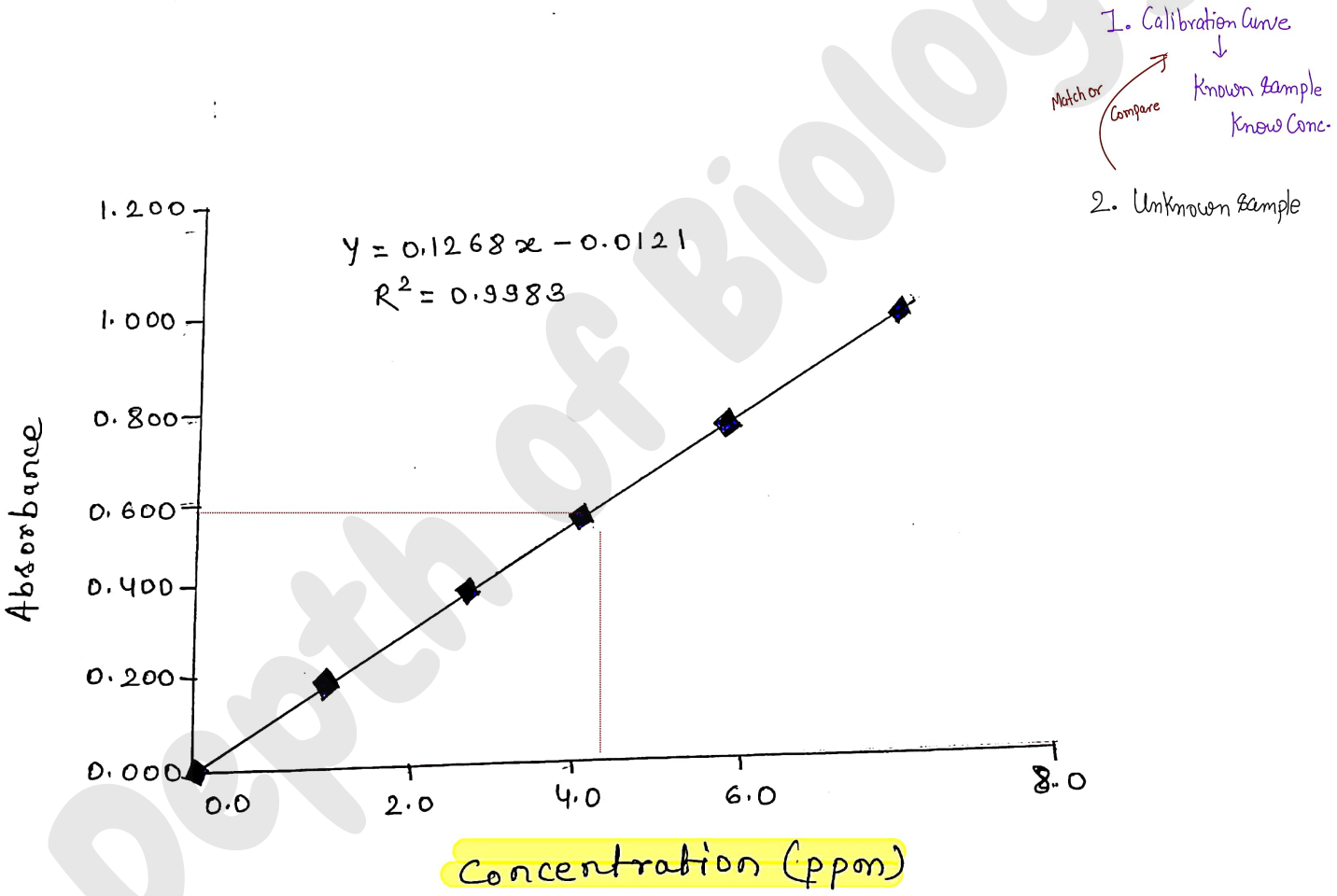
Atomisation steps :–

1. **Desolvation** (solvent evaporates)
2. **Volatilization** (Gaseous molecules formation)
3. Dissociation (molecules dissociate & produce atomic gas)
4. Ionization
5. Excitation



Instrumentation - Atomic Absorption Spectroscopy





- Hollow Cathode Lamps most commonly Used.
- It is a tube like structure in which Inert Gases like Ar, Neon are filled at low pressure

- Here Cathode is present which is made up of Metal of Intrest, means suppose if we want to analyse Na in Sample Then Cathode is made up of Na.

- Or if you want to analyse Ca, Mg in sample then our Cathode is made up of Ca or Mg

- In Hollow Cathode Lamp Anode is also present
- We applied High Voltage b/w Cathode & Anode due to this the Inert Gas which is filled in Hollow Cathode Lamp get ionised.
- This ionised atom of Inert gas hit the Cathode. due to this Metal of Intrest release & form Cloud.

- Metal of Intrest (example Na) are released & form Cloud some of this atom of Na are Present in Higher Energy State

- Na + in excited or higher state is unstable so it releases a photon of 589 nm and gets back to ground state
- Each atom absorb & emit a specific wavelenght of light.
- Eg: Na→ Absorb or emít 589 nm Wavelenght of light & this released energy passed from tube & fall on sample.

Sample insertion

- High Intensity of light / beam fall on sample due to which sample Molecule Sublimate.
- And with the help of flow of Inert gas the sublimate molecule reaches to Atomizer (Flame).
- But if our sample is present in solution form then our first Step is Nebulization

- Our Sample solution is Converted into Tiny droplets with the help of Nebulizer.

- This tiny droplets Now mix with Oxidant & fuel, then this tiny droplets along with fuel oxidant reaches to atomizer & role of atomiser is to form atoms. There are different types of atomiser but most commonly used is flame atomiser

- Different steps takes place in atomiser (Atomization steps)
- Desolvation- (solvent evaporates)
- Volatization -solute molecules Converted into Gaseous molecules.
- Dissociation- Gaseous molecule dissociate & produce atomic gas (& Ionization & Excitation).
- The released energy from the the tube falls on atoms.

- If our, Sample Contain Na then absorbtion of light takes Place

- More will be the Na in our Sample more, will be the light absorbed.

- rest Light will be Transmited & falls on Monochromator

- This Light further reach to detector/multiplier /PMT (Multiplies the signal)

- Grating is set by software so, A Light of specific wavelenght is only passed from it (589 nm)
- multiplier (PMT) amplified the signal
- Amplified signal detected by System

- And final data will be obtained in the form of Graph.
- Graph obtained in the form on Absorbence or Concentration.
- In,which we Check the Absorbance by changing the Concentration (ppm).