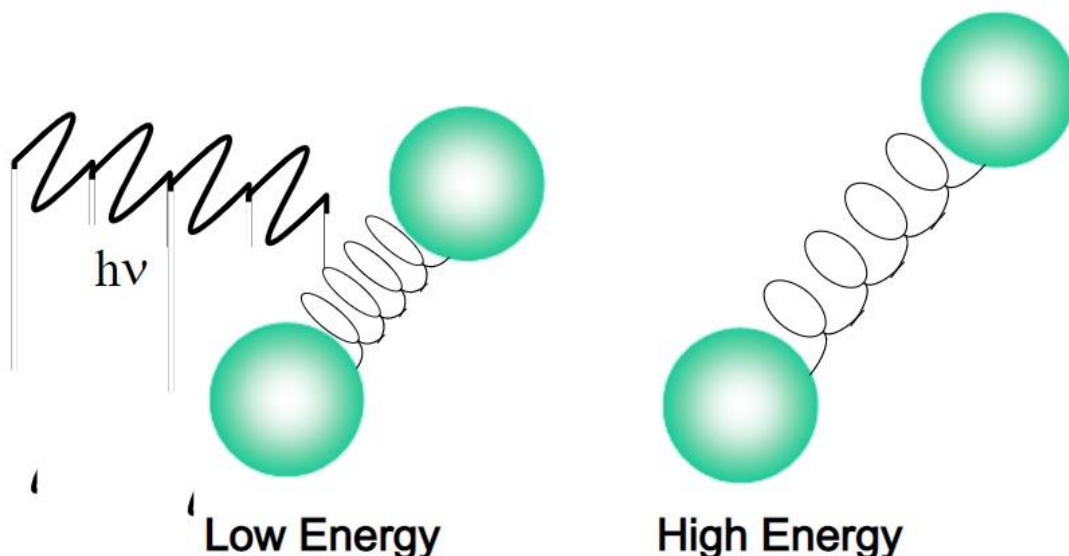


# IR/FTIR Spectroscopy

## Introduction:

Electromagnetic radiation, or EMR, includes all of the types of energy that can be seen, felt or recorded. Visible light is an example of EMR, and visible light, reflecting off objects enables us to see those objects. Other forms of EMR, such as X-rays and gamma rays, cannot be seen by the naked eye and can be dangerous to humans. EMR is measured in wavelengths, and the shorter the wavelength, which is the distance of the trough between two high points in the EMR wave, the greater the energy used to create the radiation.

- Measures heat or thermal energy in a molecule or a system
- IR spectroscopy measures the absorption of light due to bond stretching or bending
- IR energies correspond to the energies of bond stretching in most molecules
- Different types of bonds absorb at different energies (frequencies)



## - What is IR?

It is a region of the electromagnetic radiation spectrum where wavelengths range from about 700 nanometers (nm) to 1 millimeter (mm). Infrared waves are longer than those of visible light, but shorter than those of radio waves. Correspondingly, the frequencies of IR are higher than those of microwaves, but lower than those of visible light, ranging from about 300 GHz to 400 THz.

Infrared light is invisible to the human eye, although longer infrared waves can be sensed as heat. It does, however, share some characteristics with visible light -- namely, infrared light can be focused, reflected and polarized.

The infrared light is absorbed at specific frequencies related to the vibrational bond energies of the functional groups present in the molecule. A characteristic pattern of bands is formed, which is the vibrational spectrum of the molecule. The position and intensity of these spectral bands provide a fingerprint of molecular structure.

## - What is FTIR Spectroscopy?

It is an analytical methodology used to understand the structure of individual molecules and the composition of molecular mixtures. FTIR spectroscopy uses modulated, mid-infrared energy to interrogate a sample. Making FTIR spectroscopy a highly adaptable and useful technique. FTIR spectroscopy is a great advance over the traditional dispersive InfraRed approach for a number of reasons including that the entire FTIR spectrum is collected in a fraction of a second and, by co-adding spectra, signal to-noise is improved.

The definition of FTIR comes from the fact that a mathematical process known as Fourier Transform is used to convert raw data into a readable spectrum.

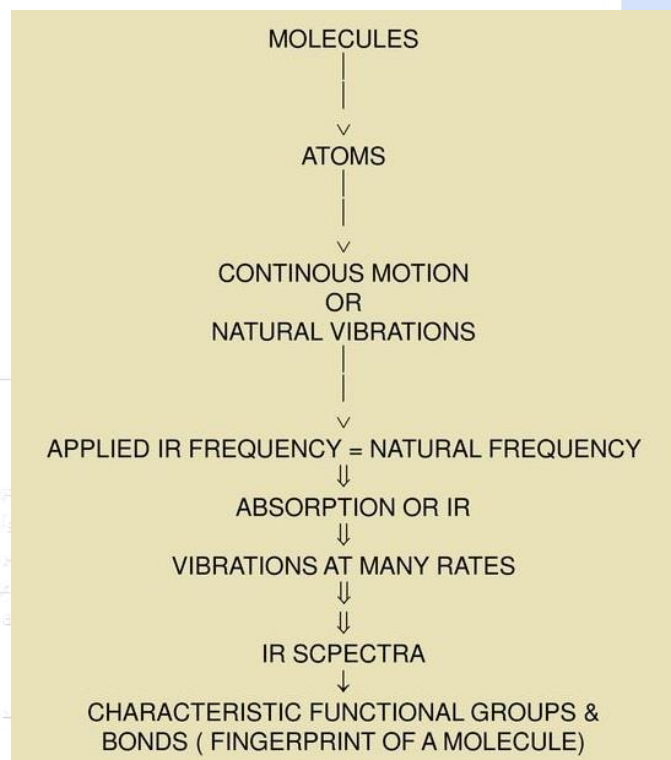
## - Fourier Transform:

The Fourier Transform is a tool that breaks a waveform (a function or signal) into an alternate representation, characterized by sine and cosines. The Fourier Transform shows that any waveform can be re-written as the sum of sinusoidal functions.

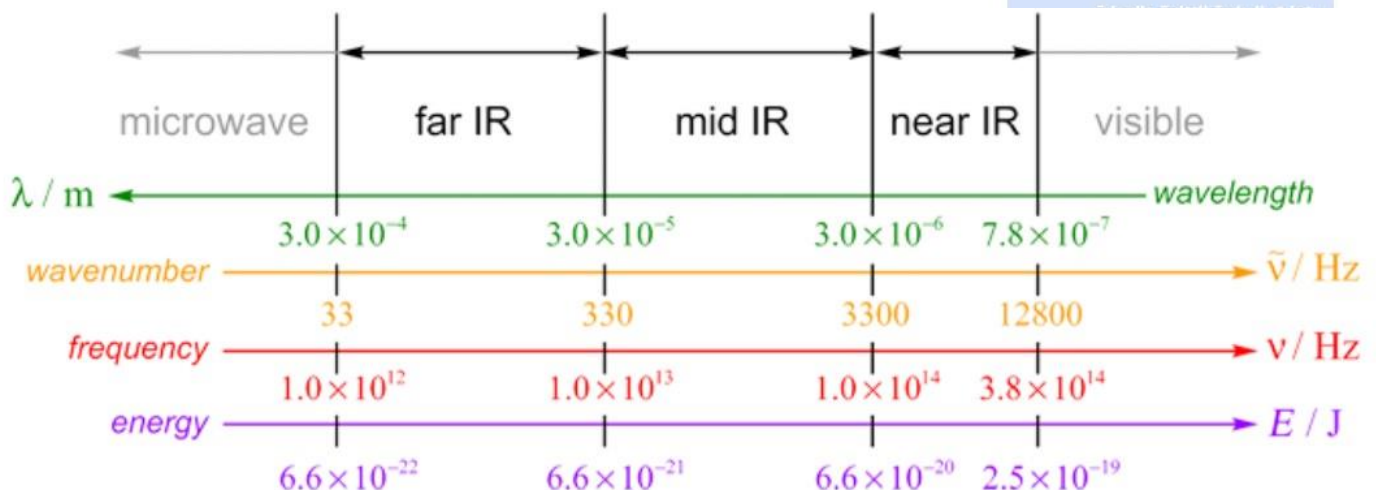
$$\mathcal{F}\{g(t)\} = G(f) = \int_{-\infty}^{\infty} g(t)e^{-i2\pi ft} dt$$

$$\mathcal{F}^{-1}\{G(f)\} = g(t) = \int_{-\infty}^{\infty} G(f)e^{i2\pi ft} df$$

## - IR Mechanism:



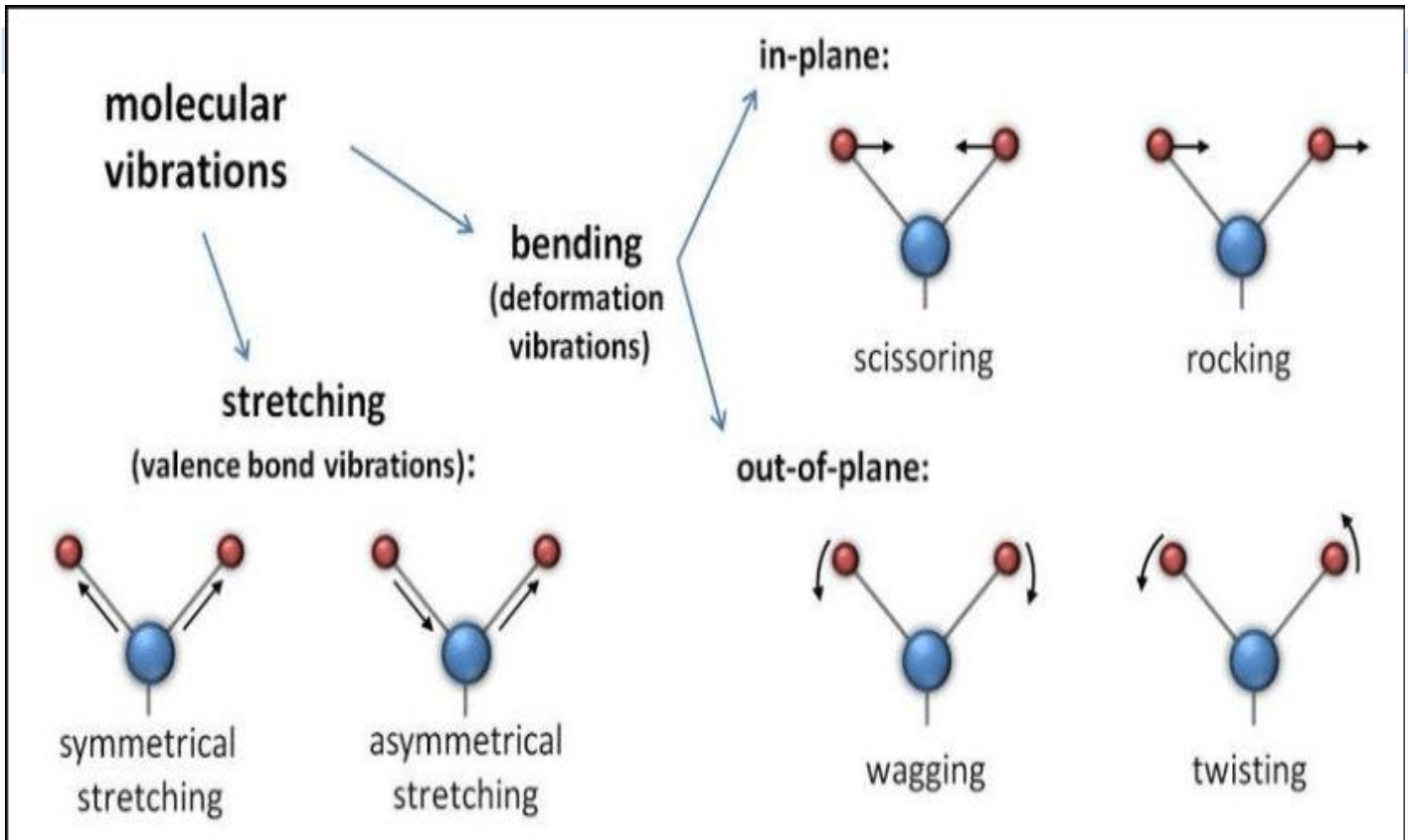
## - IR Range:



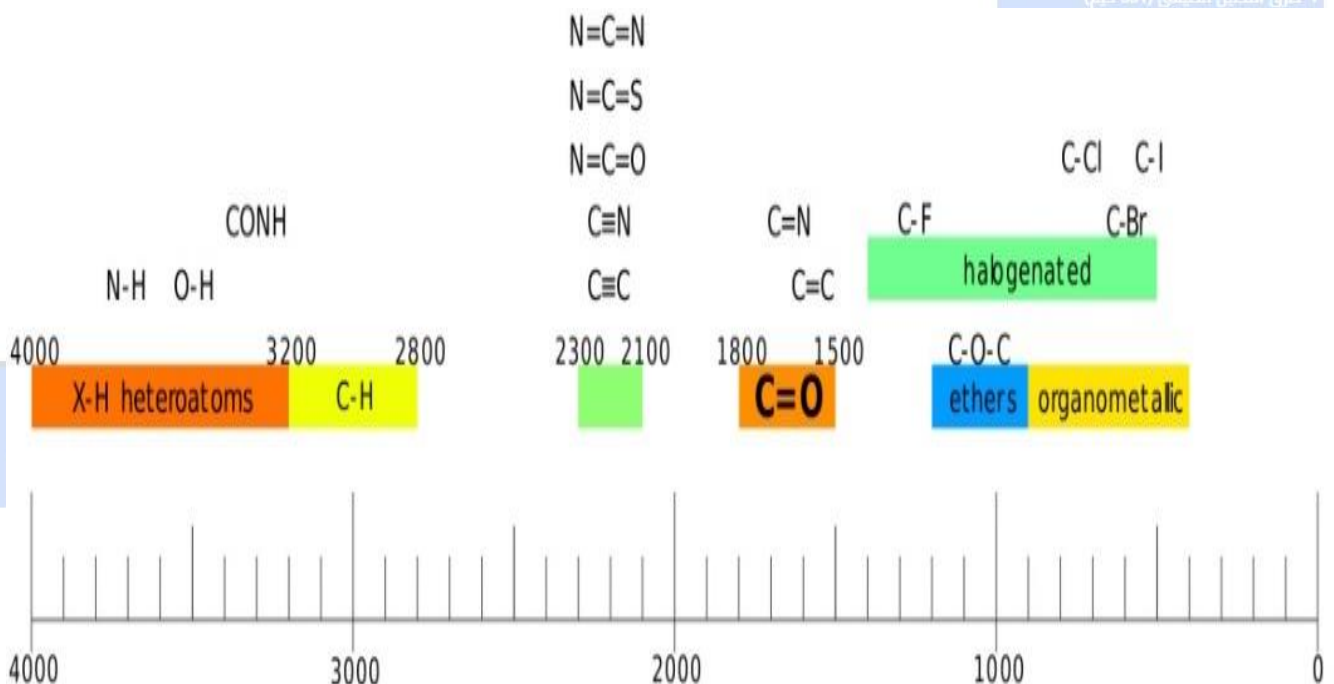
## - IR Main uses:

IRS performs qualitative and quantitative analysis of organic compounds and to determine the chemical structure of many inorganic compounds.

## - Molecules Movement Vibrations:



## - IR Spectrum:



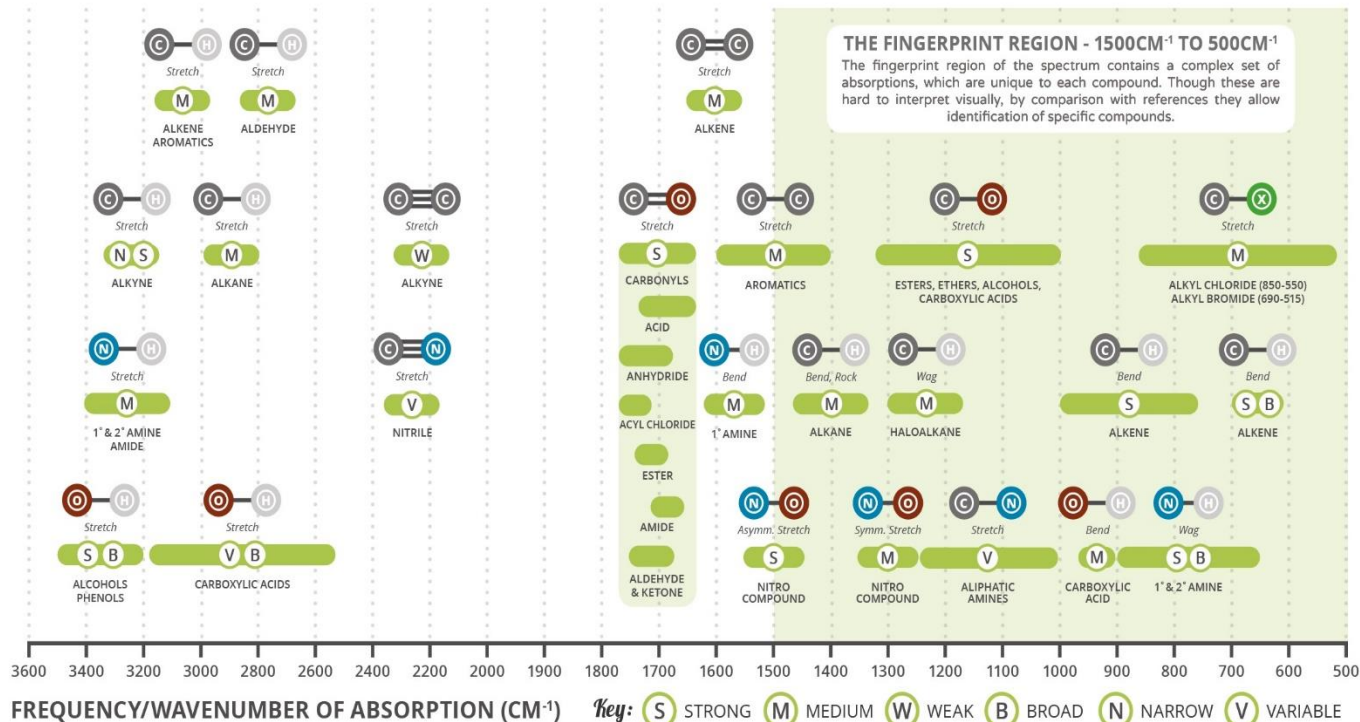
تركي الصالح الخليوي  
خبيرة تحليل



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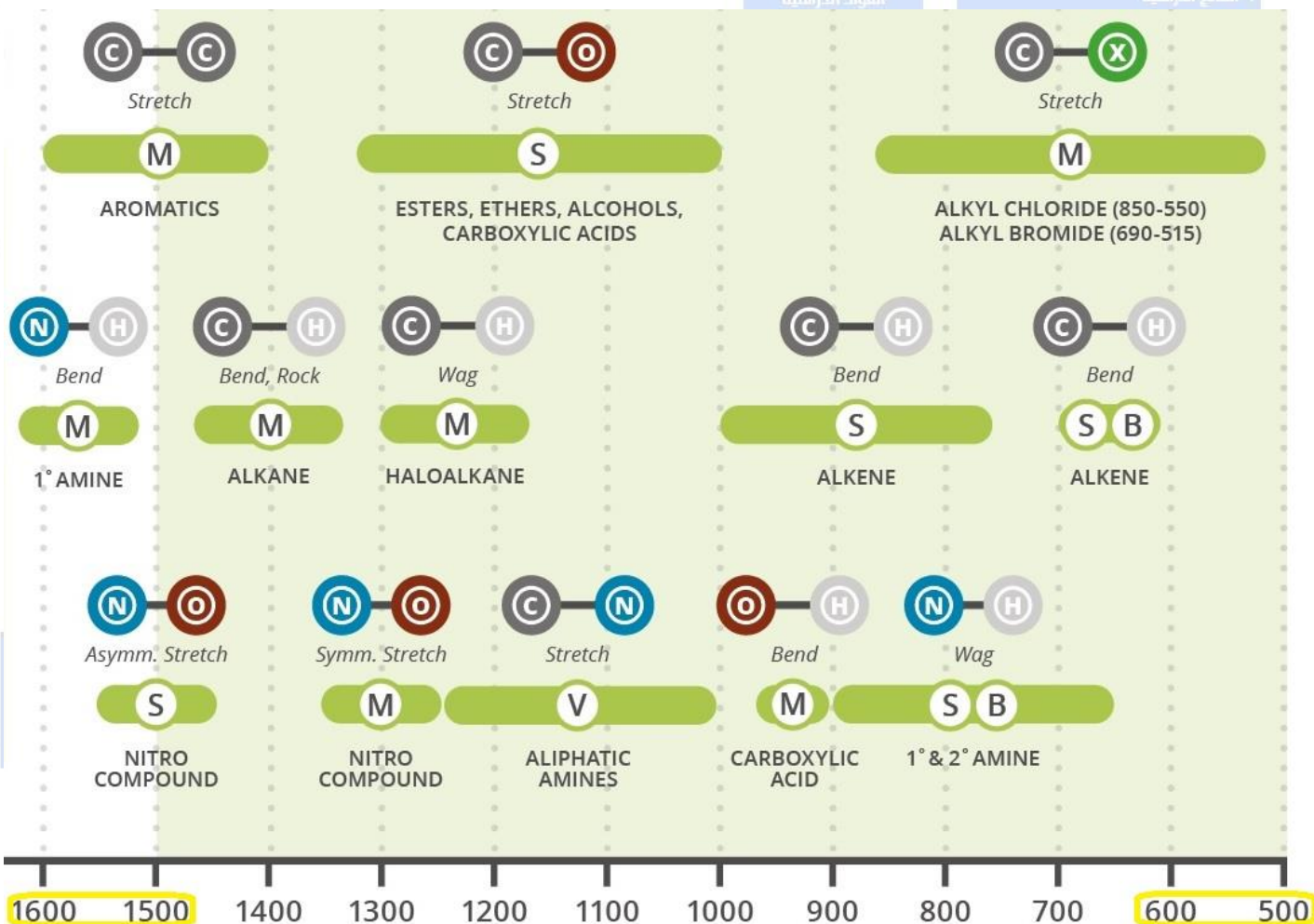
- كيمياء
- التدريب على الأجهزة (497 كيم)
- طرق الفصل الكيميائية (451 كيم)
- طرق التحليل الكهربائي (352 كيم)
- طرق التحليل الطيفي (351 كيم)

Commonly referred to as IR spectroscopy, this technique allows chemists to identify characteristic groups of atoms (functional groups) present in molecules.



Infrared frequencies make up a portion of the electromagnetic spectrum. If a range of infrared frequencies are shone through an organic compound, some of the frequencies are absorbed by the chemical bonds within the compound. Different chemical bonds absorb different frequencies of infrared radiation. There are a number of characteristic absorptions which allow functional groups (the parts of a compound which give it its particular reactivity) to be identified. This graphic shows a number of these absorptions.

## Fingerprint Region:

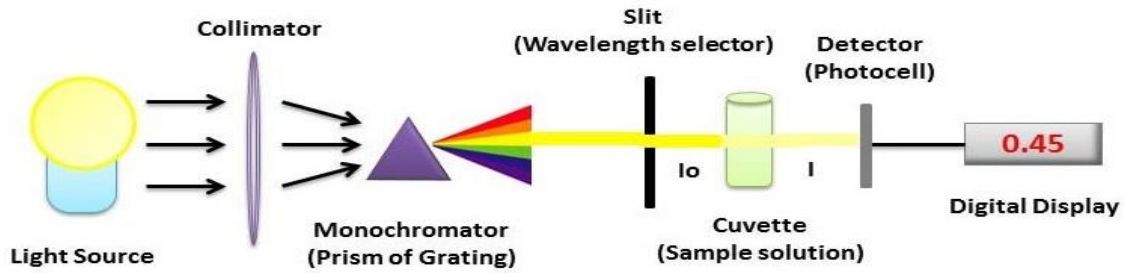


- موانع كيميائية
- موانع كيميائية
- جداول دورية
- النتائج الدراسية

البيانات الدراسية

الفريد

## - Instrumentation:

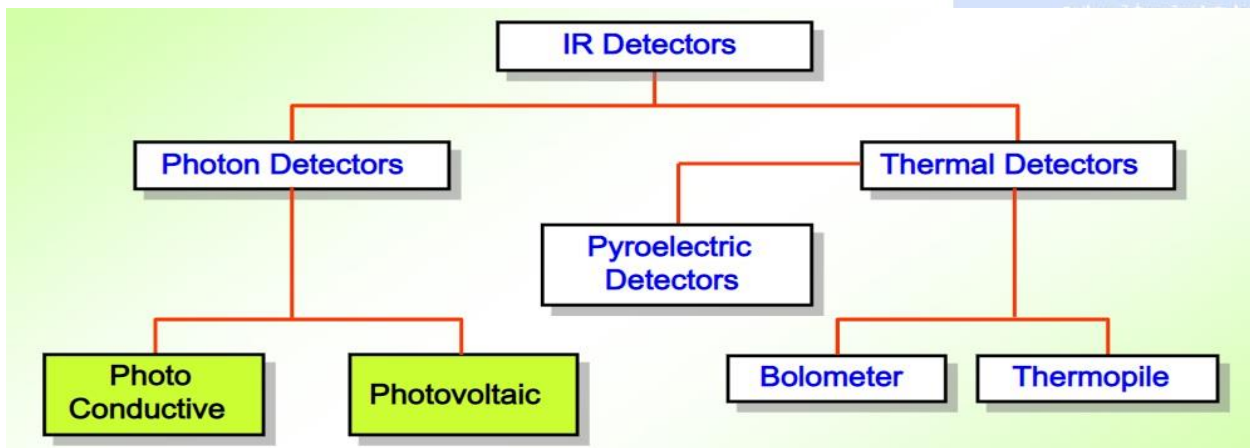


## Radiation Source:

- Tungsten filament lamp →
- Nernst glower:
  - a. Zirconium, Yttrium, Thorium
  - b. Heated to 1000 to 1800°C
  - c. Radiation –  $7100\text{cm}^{-1}$  ( $1.4\mu\text{m}$ )
- Globar source:
  - a. Silicon carbide
  - b. Heated to 1300 to 1700°C
  - c. Radiation –  $5200\text{cm}^{-1}$  ( $1.9\mu\text{m}$ )
- Mercury arc
  - a. Heated quartz – shorter wavelength
  - b. Mercury plasma – longer wavelength
- Nichrome wire or coil
  - a. Heated by passage of current to 1100°C



## Detectors:



## Sample States:

- Most flexible system for analyzing all 3 states of matter (solid, liquid, gas)
- “Neat” (analysis of liquids/oils)
- Pellet (analysis of solids)
- Thin Cell (analysis of dissolved solid samples - solutions)
- Long Cell (analysis of gases)