Spectroscopy

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SPECTROSCOPY

- Interaction of electromagnetic radiation with atoms /molecules.

Suggested Books

1. ***Atkins*, Physical Chemistry, 9th edition, 2009**
2. ***Banwell & McCash,* Fundamentals of Molecular Spectroscopy, 4th edition, 1996**

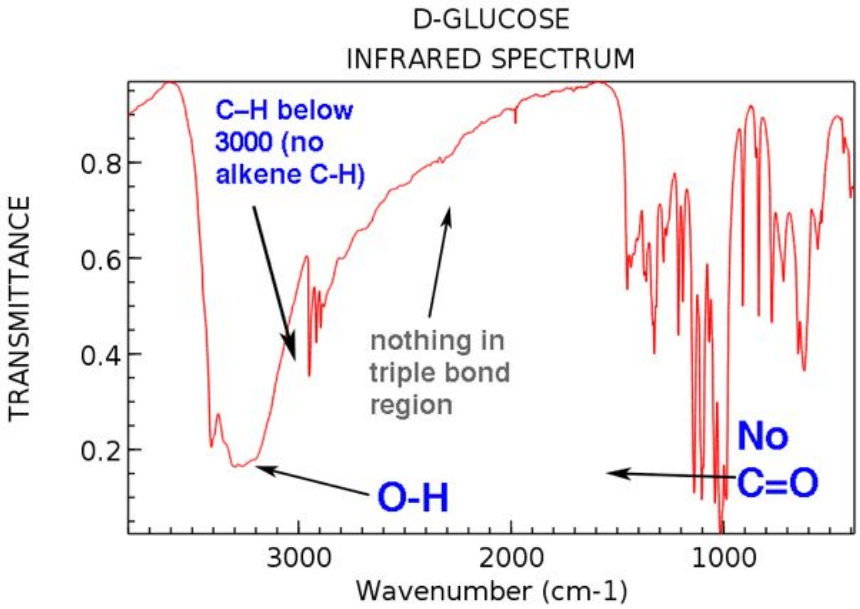
- **What Is Spectroscopy?**

Spectroscopy is the *study* of the interaction of electromagnetic radiation with matter.

The detection and analysis of the electromagnetic radiation absorbed or emitted by species.

What Is a Spectrum/spectra?

A spectrum is a plot of the intensity as a function of wavelength (or frequency or wave number, etc.) of the radiation emitted or absorbed by an atom or molecule.



Various Types of Spectroscopy

- **Atomic spectroscopy**

1. Electronic transition

- **Molecular spectroscopy**

1. Electronic transition
2. Vibrational transition
3. Rotational transition

Molecular spectroscopy is more complex than atomic spectroscopy.

What Information Is Obtained?

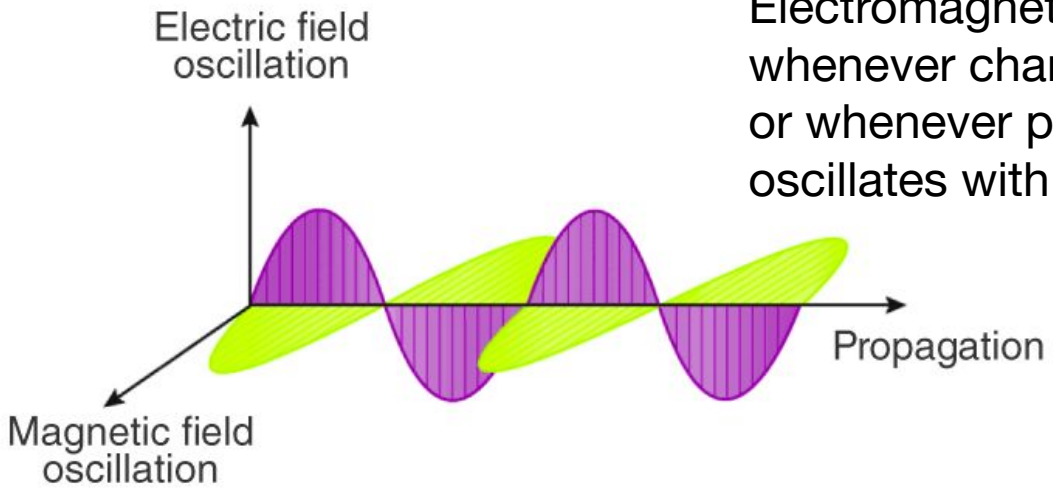
- Atomic and molecular energy levels, bond strengths, bond angles, molecular shape, dipole moments etc.

- Often, spectra are used to identify the components of a sample (qualitative analysis). Spectra may also be used to measure the amount of material in a sample (quantitative analysis).

- Compared to chemical analysis, spectroscopic methods are faster and more accurate, require less sample, and are usually nondestructive.

What is electromagnetic radiation?

- EMR consists of oscillating electric and magnetic fields directed perpendicular to the direction of propagation of the wave.



Electromagnetic waves are produced whenever charged particles are accelerated or whenever positive and negative charge oscillates with respect to each other.

Ex: Radio waves, microwaves, IR, Visible light, UV light, X-rays and γ-rays

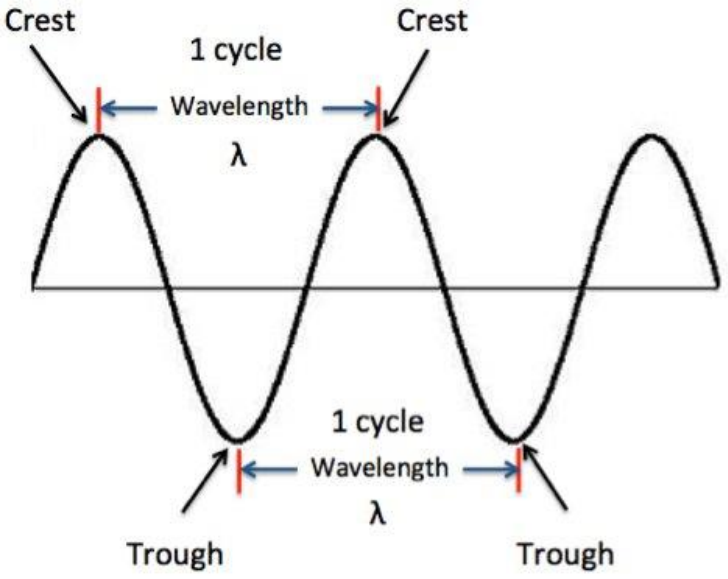
Electromagnetic Radiation

The wave nature of an electromagnetic radiation is characterized by the following wave properties.

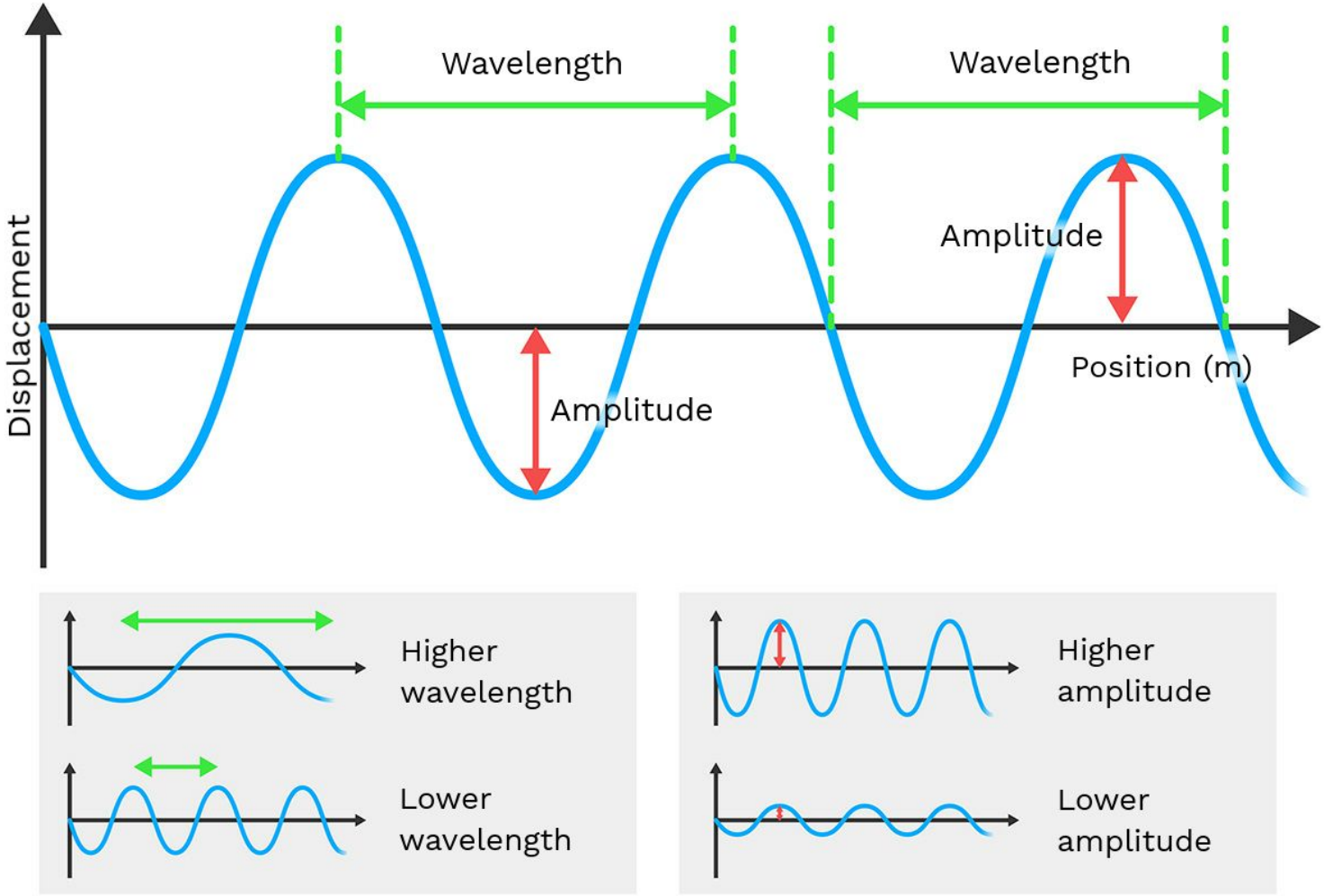
1. **Wavelength (λ)**
2. **Time Period (T)**
3. **Frequency (ν)**
4. **Wavenumber ($\bar{\nu}$)**

Wavelength (λ)

The wavelength of a wave is the distance between two consecutive maxima or two consecutive minima on the wave.



Crest, Trough and Wavelength


Wavelength
Wavelength
Displacement
Amplitude
Amplitude
Position (m)
Higher wavelength
Lower wavelength
Higher amplitude
Lower amplitude

Time Period (T)

The time required for one wavelength to pass a fixed point in space.

It is expressed in seconds

Frequency (ν)

The number of wavelengths passing a fixed point in space per second.

$\nu = 1/T$

It is expressed in hertz (Hz), kilohertz(kHz), megahertz (MHz)

The frequency of the wave is directly proportional to the energy of the wave.