Basics of spectroscopy

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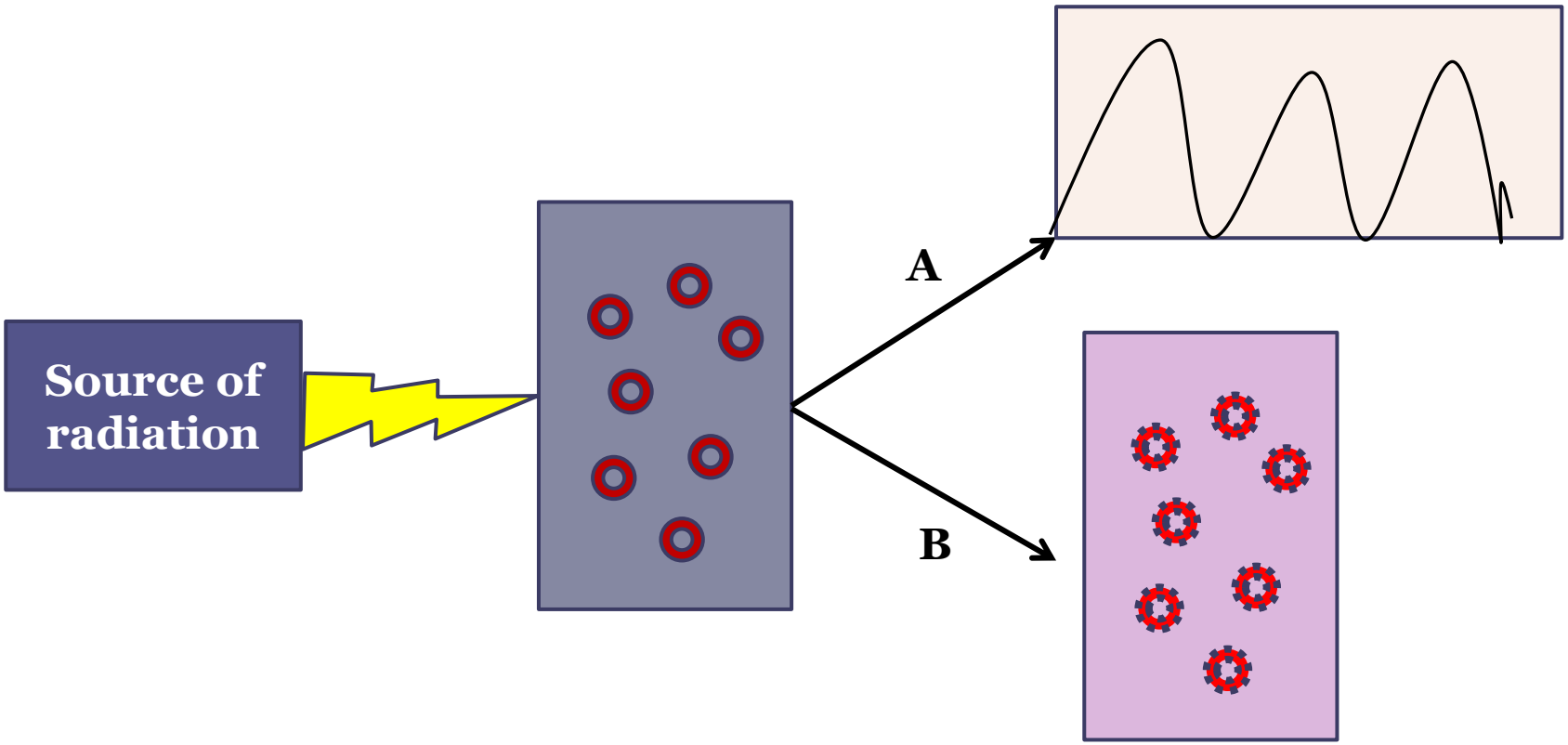
What is spectroscopy???

- In general terms spectroscopy can be simply defined as the interaction of radiation with matter. The study of interaction of light wavelength with matter and revelation of its properties is known as spectroscopy.
- The varying frequency of radiation interacts with matter at various energy levels and provide results in reference to its properties. The result obtained is known as the “spectrum”.
- It not only tells about the energy level but also reveals dynamics, structure and symmetry of the molecules.

How does spectroscopic investigations help?

- Tells about the quality of the matter being investigated.
- Tells about the quantitative aspects of the matter under study.
- Finding about the reaction pathway and dynamics of the reaction.
- Investigation of short lived species generated during any reaction.

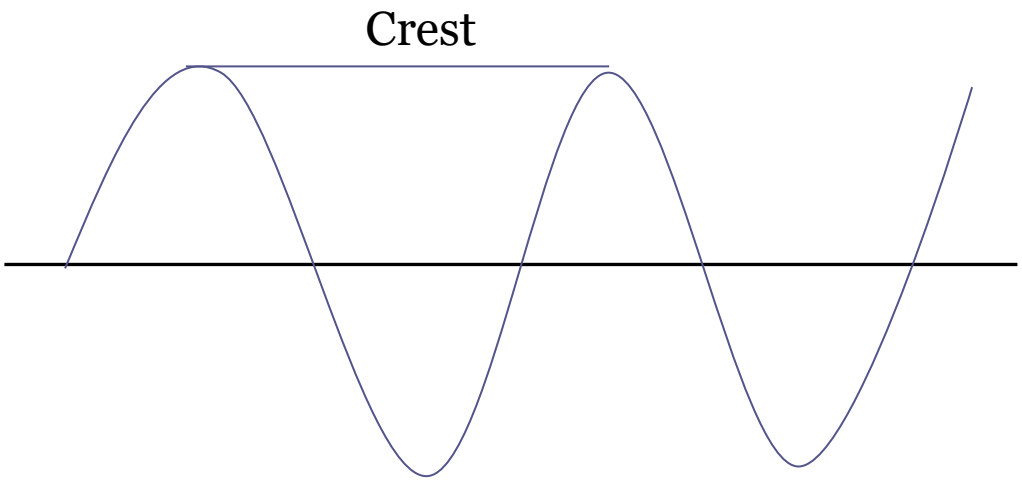
Interaction of light with matter



A The first process is spectroscopic data measurement

B The second one shows the molecules being excited after the irradiation and is part of photochemistry

A graphical representation of how an electromagnetic radiation travels. Both electric and magnetic components are perpendicular to each other

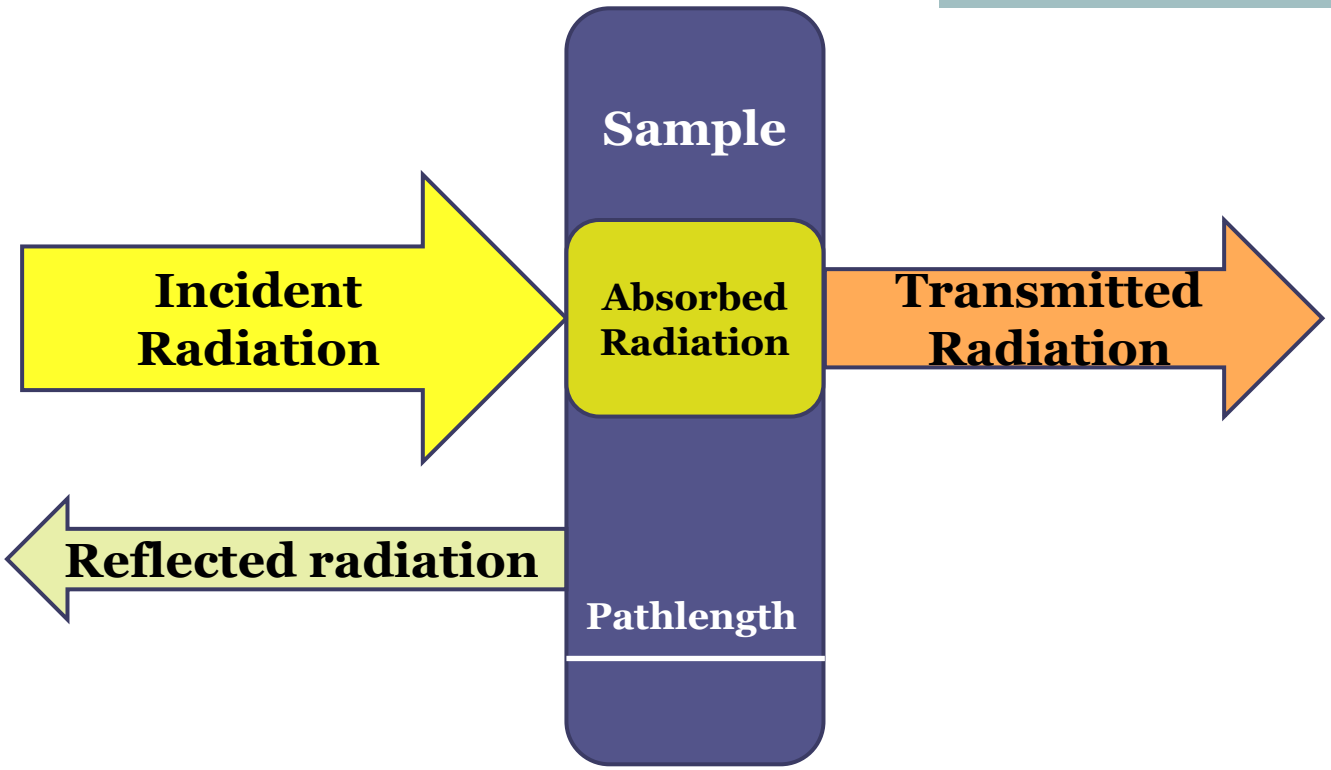


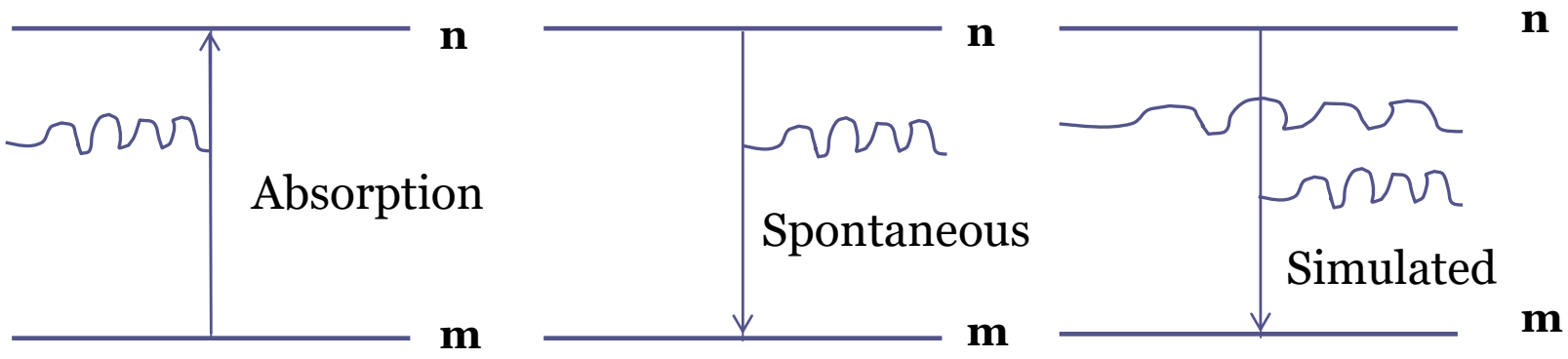
The distance between two crests is known as wavelength.

One cycle is the number of waves lying between two successive crests. The frequency ν of the wave is the number of cycles passing a given point per unit time.

The unit of wavelength λ is 'm' and that of frequency is hertz (H).

$E = hc/\lambda = h\nu$ where c is the velocity of light and h is Planck's Constant.


Sample
Incident Radiation
Absorbed Radiation
Transmitted Radiation
Reflected radiation
Pathlength


n
m
Absorption
n
m
Spontaneous
n
m
Simulated

When a set of frequencies is absorbed by a system the resultant spectrum is called **absorption spectrum** and the emitted frequency is known as **emission spectrum**. These emission spectra can either be a **line spectrum** which contains only discrete frequencies or a **continuous spectrum** which contains a continuous range of frequencies. Heated solids mostly give continuous spectrum and gases that are not but not at high pressure give line spectrum.

Any molecule which is in the stationary state *m* is exposed to an electromagnetic radiation, it may **absorb** a photon of frequency n and make a transition to a higher-energy state *n*. When the radiation's frequency satisfies the equation:

$$E_n - E_m = h\upsilon$$

Any molecule which is in stationary state *n (that is of higher* energy) in the absence of radiation can spontaneously go to a lower stationary state *m* with the emission of a photon with frequency:

$$E_n - E_m = h\upsilon$$

Such an emission is termed as **spontaneous emission** of radiation

When a molecule is exposed to electromagnetic radiation in the higher energy state n in such a way that its frequency satisfies the equation:

$$E_n - E_m = h\upsilon$$

There is an increase in the probability that this particular molecule undergoes a transition to the lower state m with emission of a photon of frequency υ.Such Emission which occurs due to the exposure to electromagnetic radiation is called stimulated emission

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