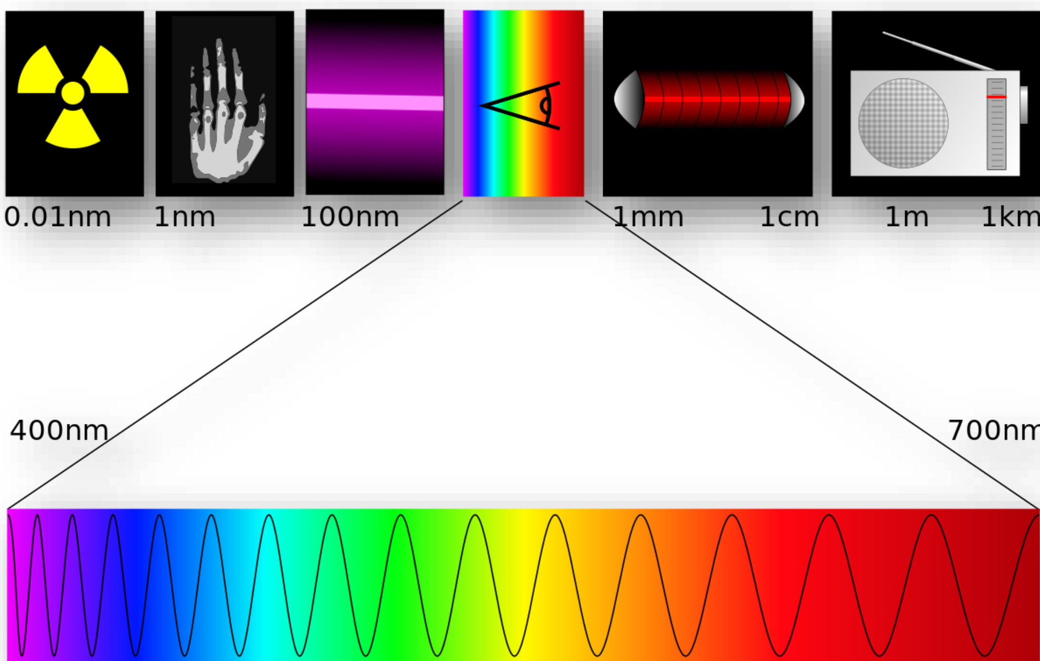
University of Mosul

College of Science

Department of New and Renewable Energies



Photochemistry

Stage 4, Semester 2

2024-2025

Lecturer: Maimoonah K. Qasim

Syllabus:

- Introduction into photochemistry
- Theories of interpretation of light
- Properties of light
- Interaction of Radiation and Matter
- Natural and Artificial Photosynthesis
- Atmospheric Photochemistry
- Solar Cells
- Theory of solar cells
- Historical Developments of solar cells
- Types of Solar Cells
- Solar Cells Generations
- Future of Solar cell Technology

References

1- Artificial Photosynthesis, From Basic Biology to Industrial Application Edited by Anthony F. Collings and Christa Critchley, 2005, Wiley -VCH.

2- Principles and Applications of Photochemistry, Brian Wardle Manchester Metropolitan University, Manchester, UK, 2009, A John Wiley & Sons, Ltd., Publication.

3- NATURAL AND ARTIFICIAL PHOTOSYNTHESIS, SOLAR POWER AS AN ENERGY SOURCE, Edited by Reza Razeghifard,2013, John Wiley & Sons, Inc.

4- Photochemistry and Photophysics, Concepts, Research, Applications, Vincenzo Balzani, Paola Ceroni, and Alberto Juris, 2014, Wiley-VCH.

5- Solar Cells: In Research and Applications—A Review, Shruti Sharma, Kamlesh Kumar Jain, Ashutosh Sharma, Materials Sciences and applications, 2015, 6, 1145 – 1155 .

http://dx.doi.org/10.4236/msa.2015.612113

6-Solar Cell Trends and the Future: A Review, A. Garg1, R. K. Ratnesh, Volume 13, Special Issue 6, 2022, Journal of Pharmaceutical Negative Results.

DOI: 10.47750/pnr.2022.13. S06.268

Introduction: -

Photochemistry is a science in which concerns the study of chemical changes or physical processes which occur in molecules as a result of absorbing radiation in the range between 200-800 nm (UV-Visible).

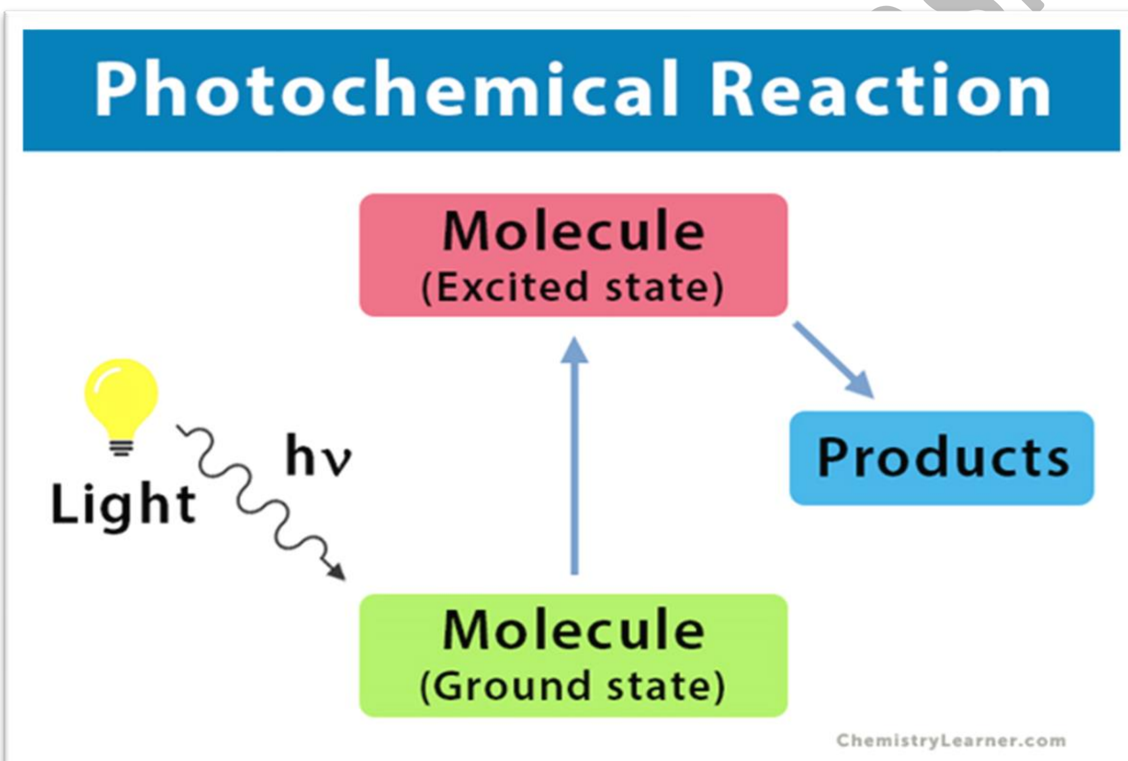


Fig. (1): Illustration of the Photochemical Reaction

This type of chemistry is concerned with:

1- reactions light and matter (atom or molecule) in chemical terms, in addition to the methods of generating it

2-The subject of photochemistry contributes to the understanding of biological interactions in living organisms and helps in understanding the phenomenon of photosynthesis,

3- photochemistry is used to prepare sources Powerful single-wave rays that can be focused to a specific point known as **laser systems** ,this term is an abbreviation for:

(**expanding or amplifying light by emission of stimulated radiation**)
These highly effective radiation systems were used in:
(Medicine, industry, and their use as lethal weapons for military purposes.)

4- Researchers have found other motivations for developing photochemistry

(energy conversion and conservation solar cell (natural source) after the exhaustion of other energy sources such as oil and coal).

The reactions which can be brought about by light radiations are called **photochemical reactions**.

Therefore, it is necessary to define light and know the theories that explain its nature and its transmission vacuum or in a material medium.

Light was defined by Newton as:

small particles that travel with straight lines, they suffer from reflection, refraction, and diffraction.

Then Hobgens came and stated that light is:

waves that propagate in space such that every point on the front of the wave becomes in turn a source of another wave.

Finally, he explained light as

electromagnetic waves that spread quickly in a vacuum 300 million meters/second **($3 * 10^8$ m/sec.).**

Light is like any wave; with a wavelength and frequency and the basic and primary component of the electromagnetic beam is photons.

The photon (is an extremely small elementary particle that is responsible for the phenomenon electromagnetism is the carrier of electromagnetic radiation of all wavelengths).

The photon has **wave properties** and **particle properties** at the same time.

Such as refraction and interference (as a wave and as a particle) when it interacts with matter by transferring an amount of energy.

Theories of interpretation of light

1. Newton's particle theory:

Newton assumed that light is very small particles it is emitted from homogeneous materials and travels in straight lines in a homogeneous medium in all directions.

This is called (the law of propagation) in straight lines and this theory it explained the photoelectric phenomenon but did not explain other phenomena such as diffraction and polarization.

2- **Maxwell's wave theory:**

The scientist James Maxwell developed his theory of light, which states that (visible light as a form of energy electromagnetism they are electromagnetic waves that have wave properties).

And he found that the speed of a wave in a vacuum is equal to the speed of light was explained by this theory most phenomena such as polarization, diffraction, reflection.

3- Einstein's theory of the photon:

Einstein's explanation was one of the most important explanations for the behavior of light, benefiting from a study the scientist Planck, who studied the radiant energy emitted by a black body he was able to calculate it from the following law

E= h v

(The light was interpreted (explanation) as a stream of photons)

How to calculate energy of photons

Since light is an electromagnetic wave that travels in a vacuum with a speed (c) and a frequency (v), the energy of a light wave can be calculated from the equation:

Energy of photons (A. Einstein)

Photon Energy : -

(Planck Equation)

$$E = hv = \frac{hc}{\lambda}$$

Where,

E = Photon Energy

h = Planck constant $= 6.6261 \times 10^{-34}$ J*S

c = Speed of light $= 3 \times 10^{8}$ m/s

λ = Photon wavelength

v = Photon frequency

Fig. (2): The equation of calculating Photon Energy

From this we find that the wavelength is inversely proportional to the energy and on this basis, it is divided rays found in nature depend on their wavelength.

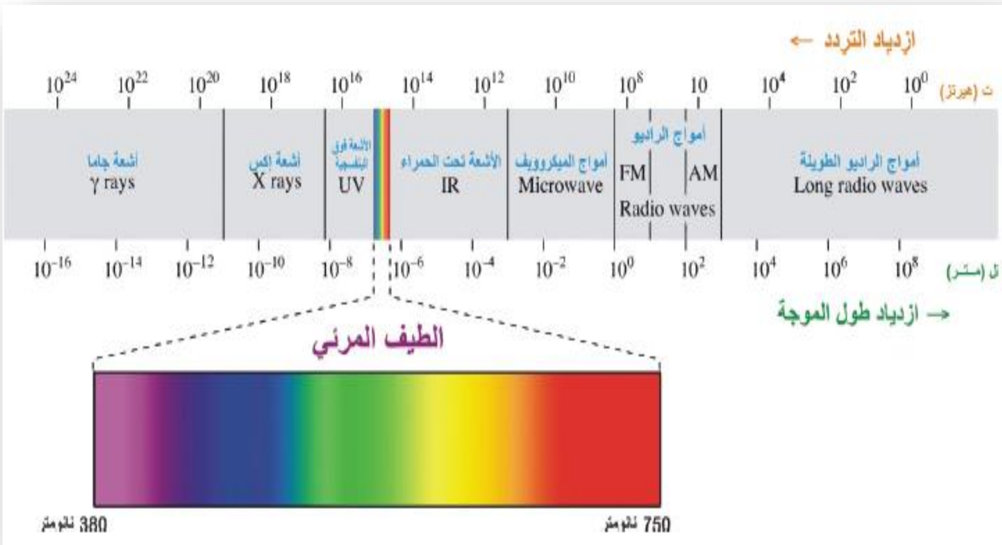


Fig. (3): Illustration of the electromagnetic spectrum

The unit of measurement for wavelength is the angstrom, and it is also measured in nanometers.

$A^o = 10^{-10}$ m

nm = 10^{-9} m

The wavelength of the visible region ranges (400-700) nanometers.

The colors of the solar spectrum have different wavelengths,

so white light when analyzed using the prism, many colors are given, which are:

Violet 400-450 nm **is more energy**

Green 450 – 500 nm

Red 625 – 760 nm **is lower energy**

Q/ What colors are used in photography so as not to affect the film?

The color is red because its energy is low.

The relevance of photochemistry also lies in its varied applications in science and technology.

Synthetic organic photochemistry has provided methods for the manufacture of many chemicals which could not be produced by dark reactions:

Some industrially viable photochemical syntheses include:

1- synthesis of vitamin D2 from ergosterol isolated from yeast,

2- synthesis of caprolactam which is the monomer for Nylon 6,

3- manufacture of cleaning solvents and synthesis of some antioxidants.

The two main processes studied under photochemistry are therefore:

1. Photophysical process
2. Photochemical process

1. Photophysical process: - In this process, the absorption of light does not result into any chemical reaction.

2. Photochemical process: - In this process, the light that is absorbed by a system result into chemical change.