ALLIED CHEMISTRY-I

18K3B/P/ZACH1

UNIT-I
NUCLEAR CHEMISTRY

COMPOSITION OF NUCLEUS

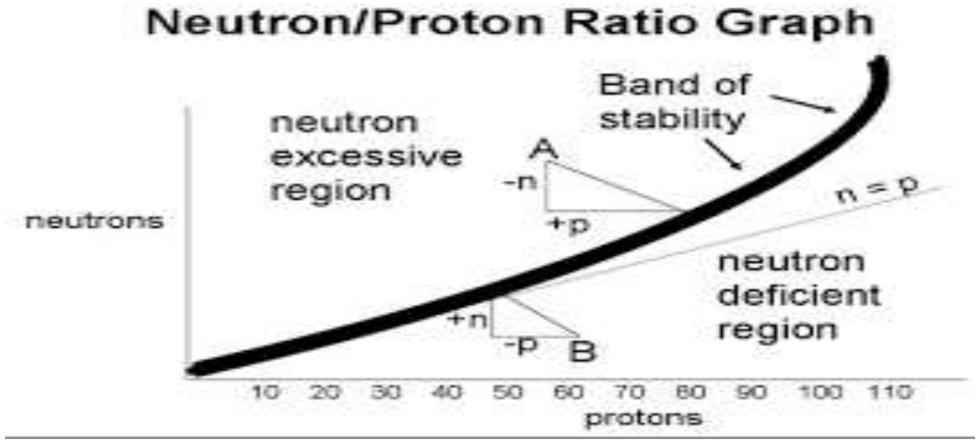
- Nucleus - proton + neutron.
- Fundamental particles
  - Stable particles- electron, proton, antiproton, positron, neutrino, photon and graviton.
  - Unstable particles- neutron, mesons and V-particles.
- Nuclear forces- Attractive forces between (p-p), (n-p) and (n-n).

  Short - range force= 0.1 fermi.
- Mass defect

Difference between the expected or calculated mass of an atom and its actual mass of an atom.

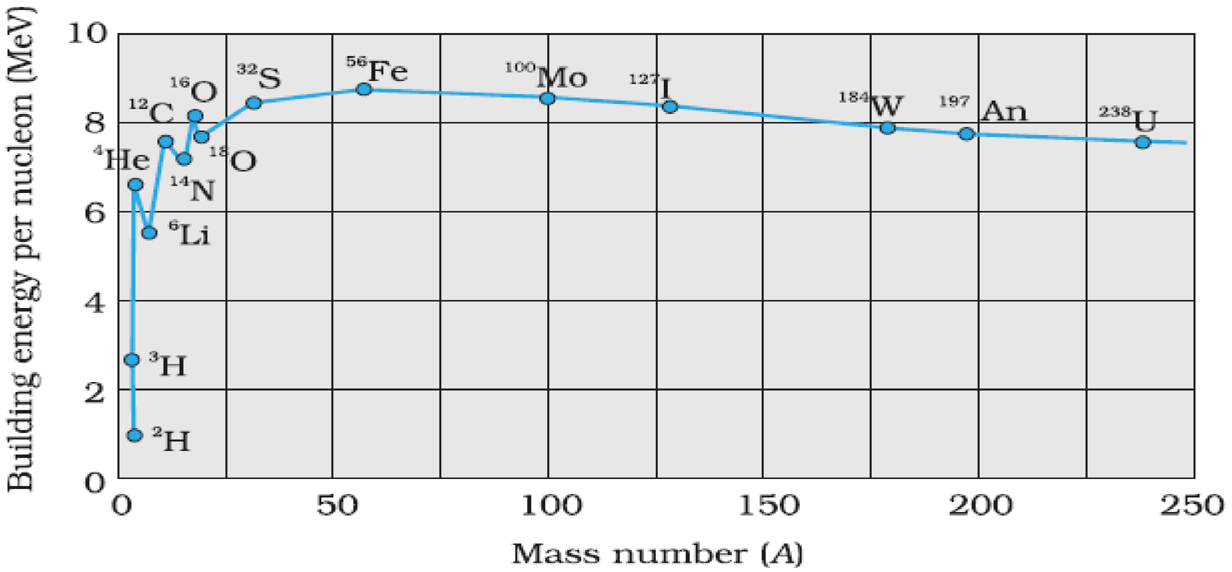
NUCLEAR STABILITY

- Three theories
- Nuclear shell structure theory
  - Odd even rule
  - Magic numbers- 2, 8, 20, 50, 82, 126
- Nuclear fluid theory- liquid drop model
- N/P ratio- ratio between number of neutrons and number of protons in the same nucleus.



BINDING ENERGY

- **Binding energy**, amount of energy required to separate a particle from a system of particles or to disperse all the particles of the system. Binding energy is especially applicable to subatomic particles in atomic nuclei, to electrons bound to nuclei in atoms, and to atoms and ions bound together in crystals.

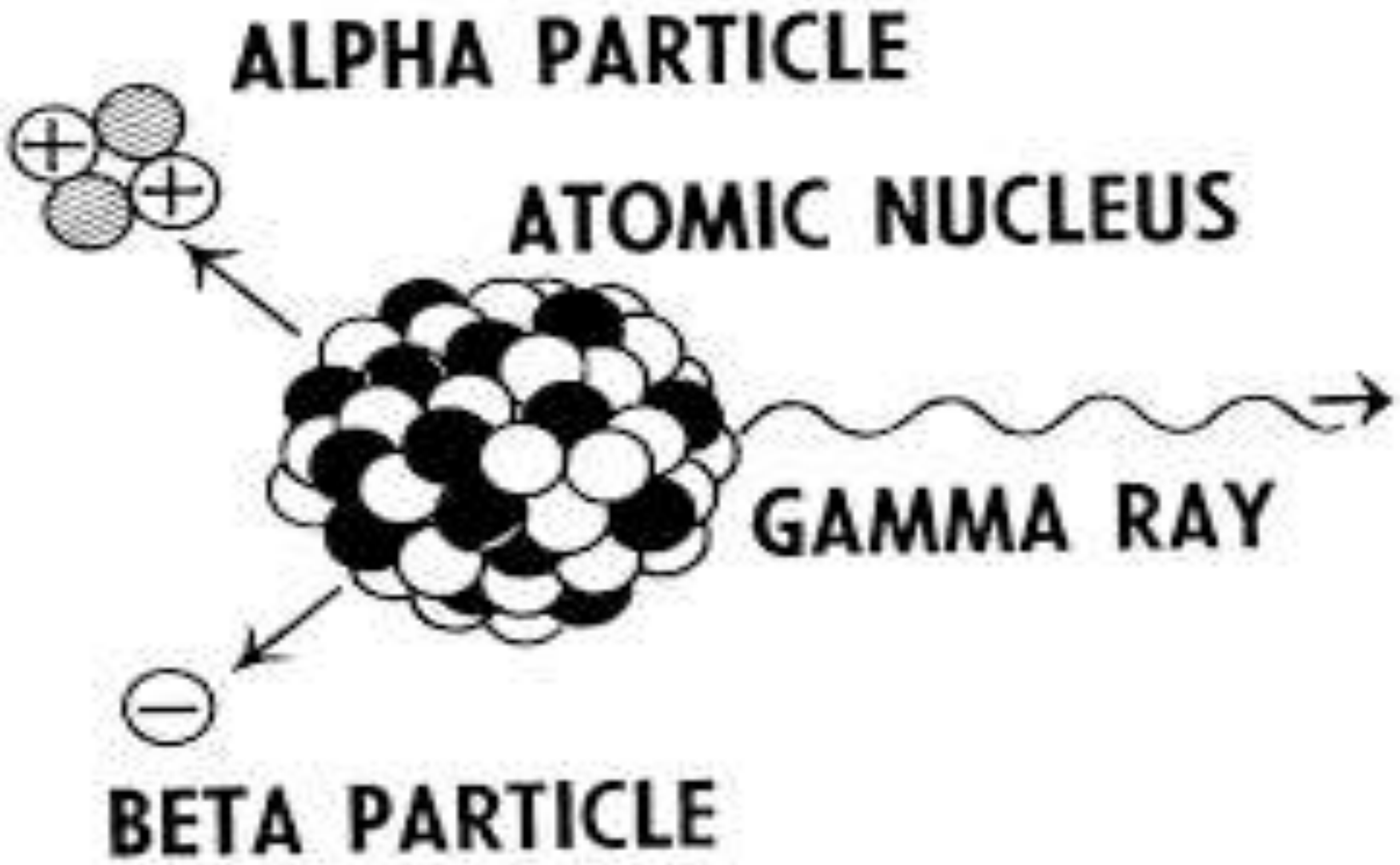


The binding energy per nucleon as a function of mass number.

RADIOACTIVITY

- All substance are made of **atoms**. These have **electrons** (e) around the outside, and a **nucleus** in the middle. The nucleus consists of **protons** (p) and **neutrons** (n), and is extremely small. (Atoms are almost entirely made of empty space!)

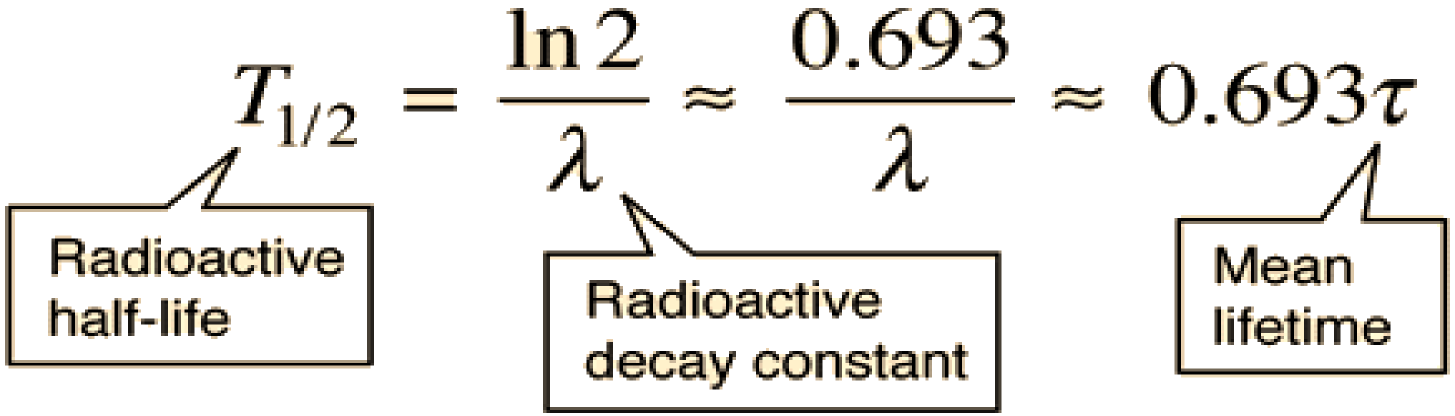
- In some types of atom, the nucleus is **unstable**, and will **decay** into a more stable atom. This **radioactive decay** is completely **spontaneous**. The energy that is released from the nucleus of the atom is **radiation**.


ALPHA PARTICLE
ATOMIC NUCLEUS
GAMMA RAY
BETA PARTICLE

HALF LIFE PERIOD

- When radioactive isotopes decay, they do so exponentially. Their rate of decay is determined through an understanding of half-life.
- Half-life is the amount of time it takes for half of the atoms of an unstable isotope to decay.

$$T_{1/2} = \frac{\ln 2}{\lambda} \approx \frac{0.693}{\lambda} \approx 0.693\tau$$



RADIOACTIVE SERIES

Four Types

- 4n series(Thorium series) – Natural series
- 4n+1 series(Neptunium series) – Artificial series
- 4n+2 series(Uranium series) – Natural series
- 4n+3 series(Actinium series) – Natural series

GROUP DISPLACEMENT LAW

Group displacement law was given by Soddy and Fazan.

LAW

1. Only one type of particle is emitted at a time.

2. When an alpha particle is emitted, the newly formed element will have an atomic number less by two units. The mass number reduces by four units while the group position is shifted two places towards the left.

3. When a beta particle is emitted the newly formed element will have an atomic number increased by one unit, while the mass number remains the same and the group position moves one position toward the right.

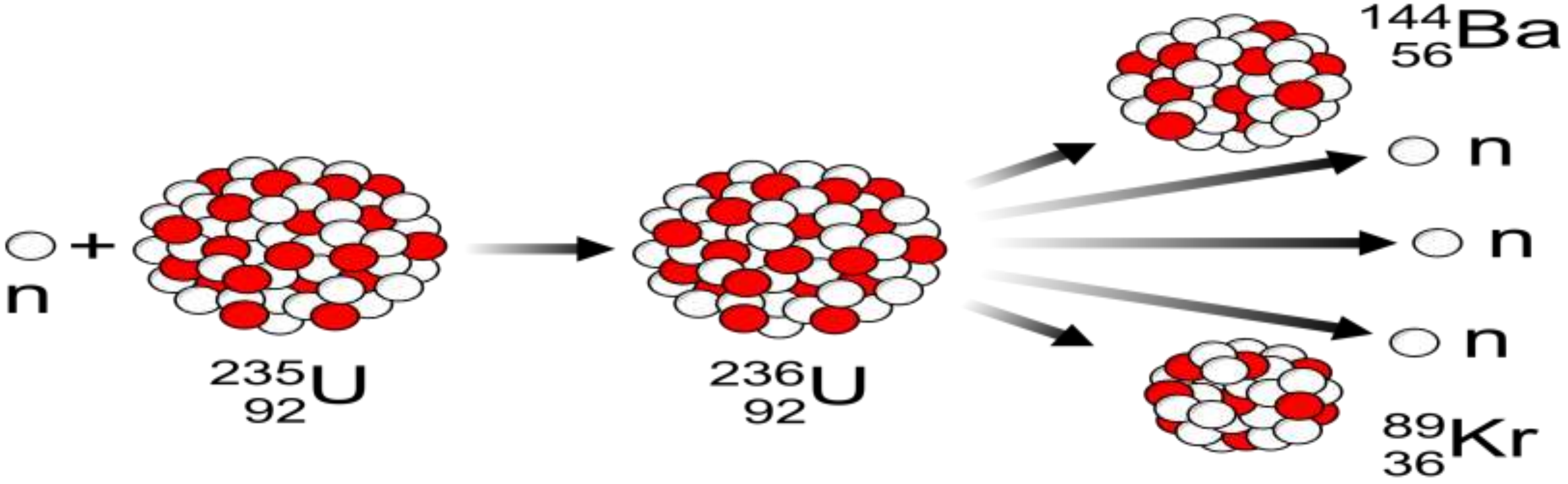
ISOTOPES AND ISOBARS

An Introduction To Atomic Number, Isotopes And Isobars

ISOTOPES	ISOBARS
➢ Atoms having same atomic number but different mass numbers .	➢ Atoms having same number of nucleons but differ in number of protons i.e. have same mass number and different atomic number.
➢ ^{123}I, ^{125}I, ^{127}I, ^{131}I	➢ ^{40}Cl, ^{40}Ar, ^{40}K, ^{40}Ca

NUCLEAR FISSION

Fission: Fission is the process of splitting an atom.



CHAIN REACTION

CHAIN REACTION

A chain reaction occurs

- When a Critical Mass of Uranium Undergoes Fission.
- Releasing a Large Amount of Heat and Energy That Produces an Atomic Explosion.

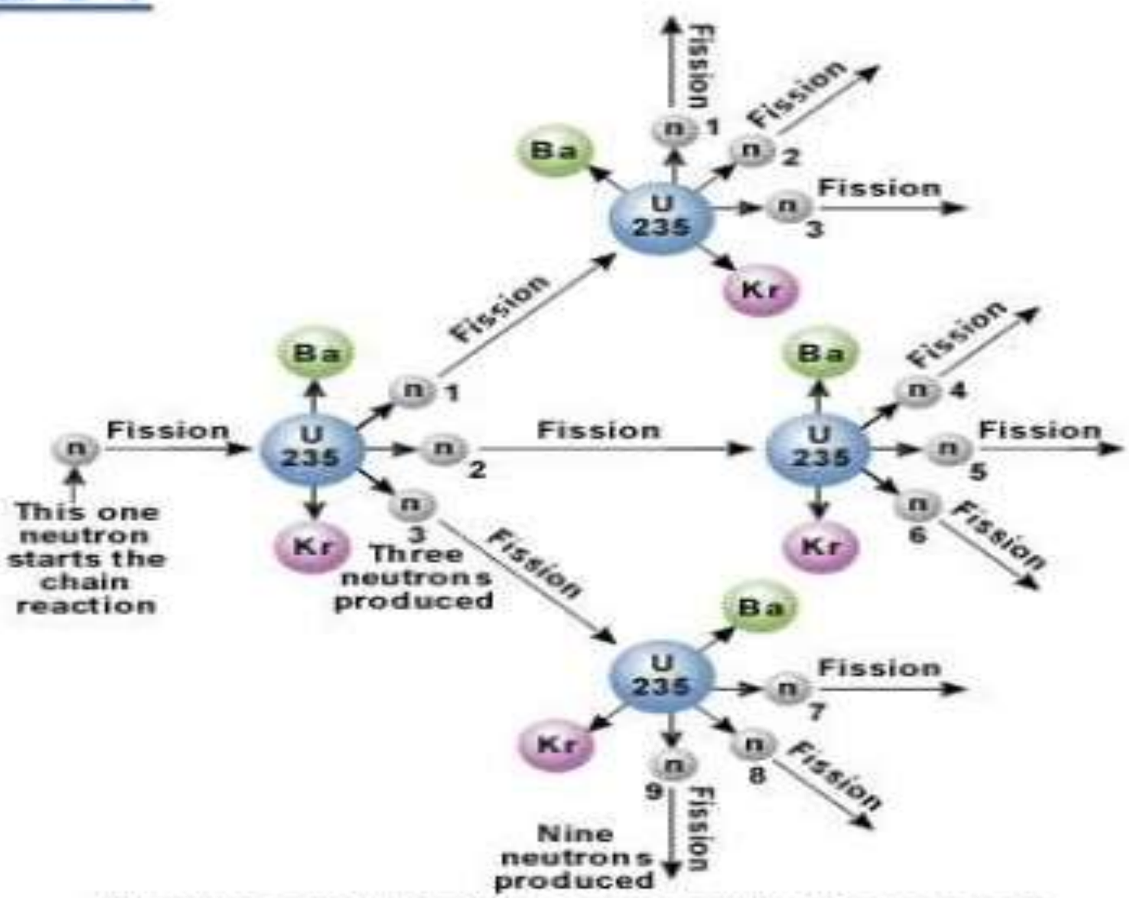
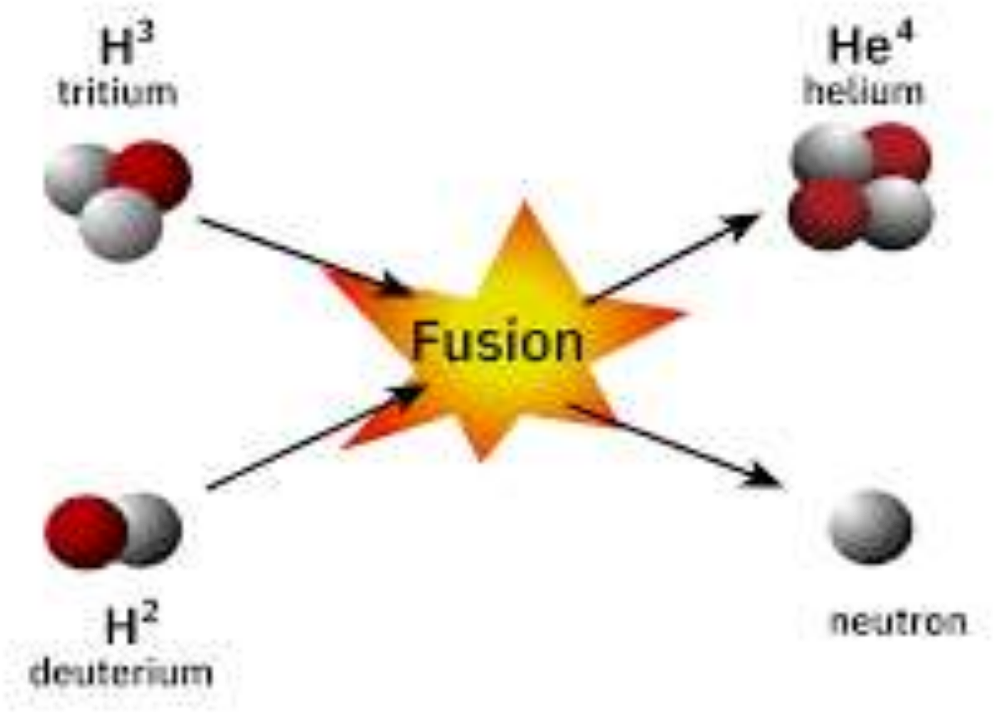


Diagram to show the chain reaction during the fission of uranium-235 with a neutron

NUCLEAR FUSION

Fusion: Nuclear fusion is the process by which multiple small atomic nuclei join together to form a heavier nucleus.



DIFFERENCE

NUCLEAR FISSION	NUCLEAR FUSION
A heavy nucleus breaks up to form two lighter nuclei.	Two light nuclei combine to form a heavy nucleus.
It involves a chain reaction.	Chain reaction is not involved.
The heavy nucleus is bombarded with neutrons.	Light nuclei are heated to an extremely high temperature.
We have proper mechanisms to control fission reaction for generating electricity.	Proper mechanisms to control fusion reaction are yet to be developed.
Disposal of nuclear waste is a great environmental problem.	Disposal of nuclear waste is not involved.
Raw material is not easily available and is costly.	Raw material is comparatively cheap and easily available.

UNIT-V
PHOTOCHEMISTRY

LAWS OF PHOTOCHEMISTRY

FOUR LAWS

- Grothus - Draper law
- Stark – Einstein’s law
- Lambert law
- Lambert- Beer’s law or Beer’s law

Laws governing Photochemistry

- **Grotthus-Draper Law:**

  Only the light which is absorbed by a molecule can be effective in producing photochemical changes in the molecule.

- **<u>Stark-Einstein's Law (Second Law of Photochemistry):</u>**

  It states that for each photon of light absorbed by a chemical system, only one molecule is activated for a photochemical reaction. The energy absorbed by one mole of the reacting molecules is given by $E=Nh\nu$. This energy is called one einstein.

Lambert's law

- When a ray of monochromatic light passes throughan absorbing medium its intensity decreases exponentially as the length of the absorbing medium increases.

$$I = I_0 e^{-k_1 l}$$

Beer's law :

- When a monochromatic light passes through an absorbing medium its intensity decreases exponentially as the concentration of the absorbing medium increases.

$$I = I_o e^{-k_2 c}$$

QUANTUM YIELD

$$\text{Quantum yield} = \frac{\text{Number of moles of substance reacting chemically in unit time}}{\text{Number of Einstein energy absorbed in time}}$$

(OR)

$$\frac{\text{Number of molecules reacting chemically in unit time}}{\text{Number of quanta of light absorbed in time}}$$

PHOTOSENSITIZATION

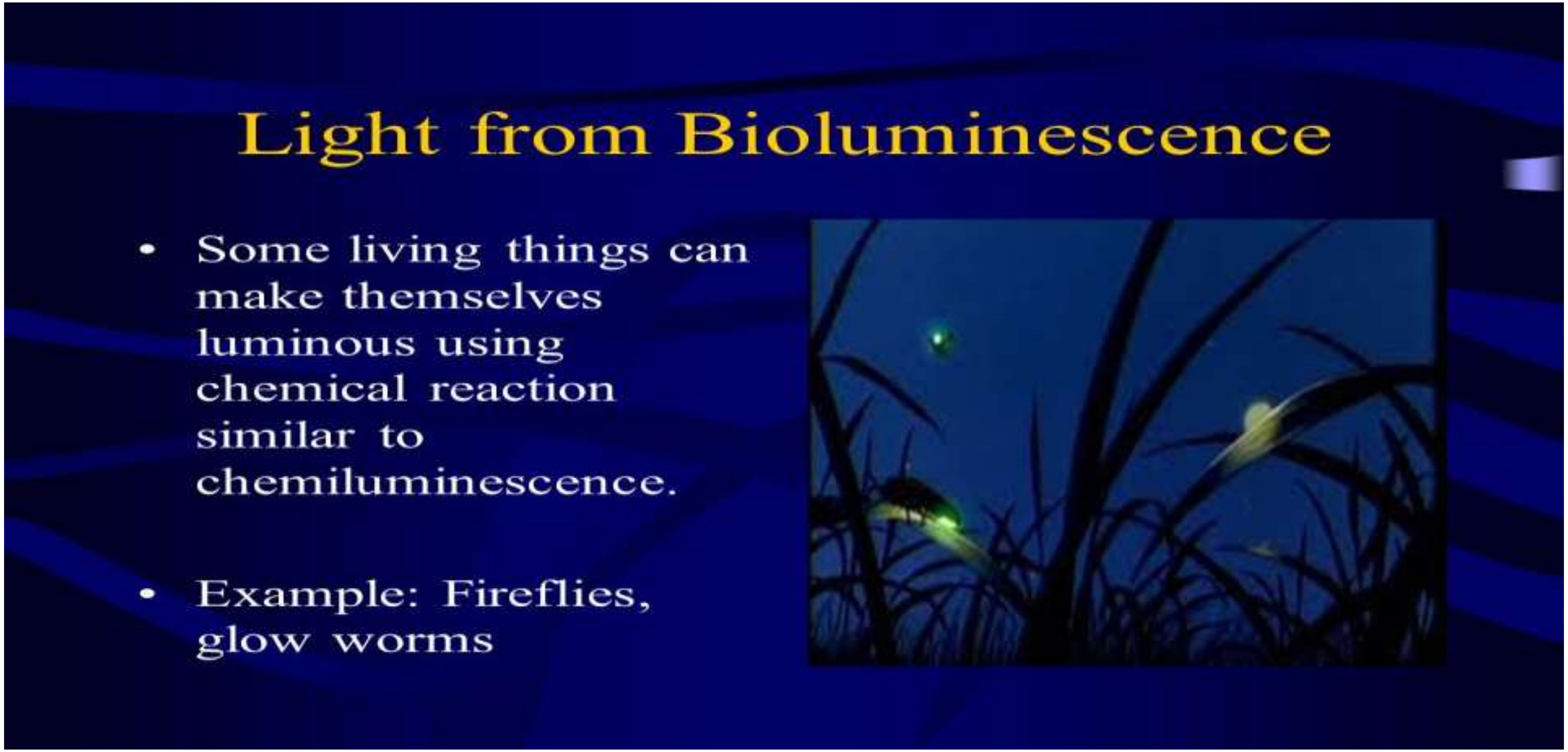
Photosensitization, the process of initiating a reaction through the use of a substance capable of absorbing light and transferring the energy to the desired reactants.

EXAMPLE

Photosynthesis, the process by which green plants and certain other organisms transform light energy into chemical energy. During **photosynthesis** in green plants, light energy is captured and used to convert water, carbon dioxide, and minerals into oxygen and energy-rich organic compounds.

CHEMILUMINESCENES

Chemiluminescence (also chemoluminescence) is the emission of light (luminescence), as the result of a chemical reaction.



CHEMICAL KINETICS

Rate of reaction

$$\text{RATE OF REACTION} = \frac{\text{Decrease in concentration of reactants}}{\text{Time in which the change takes place}}$$

In other words,

$$\text{RATE OF REACTION} = \frac{\text{Increase in concentration of products}}{\text{Time in which the change takes place}}$$

UNIT: $mole/dm^3 . Sec$

ORDER OF REACTION

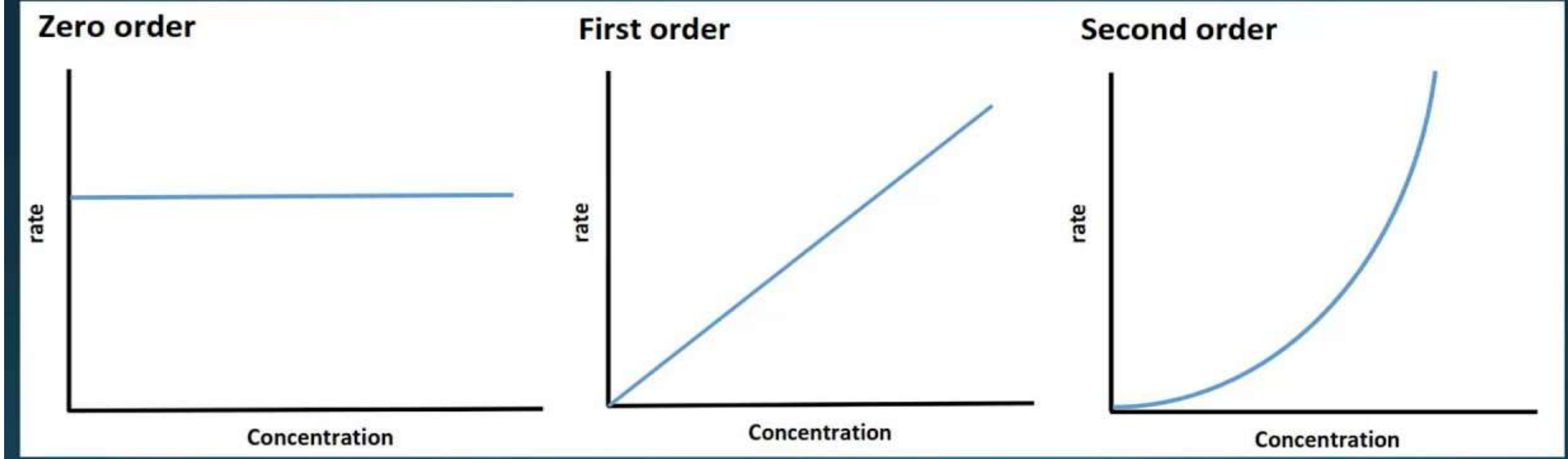
Definition

Sum of the power of the concentration terms of the reactants.

Reaction Order	Differential Rate Law	Integrated Rate Law	Characteristic Kinetic Plot	Slope of Kinetic Plot	Units of Rate Constant
Zero	$\frac{-d[A]}{dt} = k$	$[A] = [A]_0 - kt$	$[A]$ vs t	$-k$	mole L^{-1} sec^{-1}
First	$\frac{-d[A]}{dt} = k[A]$	$[A] = [A]_0 e^{-kt}$	$\ln [A]$ vs t	$-k$	sec^{-1}
Second	$\frac{-d[A]}{dt} = k[A]^2$	$[A] = \frac{[A]^0}{1 + kt[A]^0}$	$1/[A]$ vs t	k	L $mole^{-1}$ sec^{-1}

Graphs of reaction kinetics

rate vs concentration (for reactant A)



rate = k

rate = k[A]

rate = $k[A]^2$

gradient is proportional to concentration

MOLECULARITY OF REACTION

The minimum number of molecules or atoms of the reactants necessary for the reaction to take place.

EXAMPLE

- Decomposition of ozone
- Formation of HI
- Formation of NOCl

CATALYST

- A **catalyst** is a substance that speeds up the rate of a reaction without itself being consumed in the reaction.

Characteristics of catalyst

- A catalyst remains unchanged in mass and chemical composition at the end of the reaction.
- A small quantity of the catalyst is generally sufficient to catalyses almost unlimited reactions.
- **The catalyst can not initiate the reaction:** The function of the catalyst is to alter the speed of the reaction rather than to start it.
- **The catalyst is generally specific in nature:** A substance, which acts as a catalyst for a particular reaction , fails to catalyse the other reaction , different catalysts for the same reactant may for different products.
- **The catalyst can not change the position of equilibrium**

TYPES OF CATALYST

- Positive catalyst
- Negative catalyst
- Auto catalyst
- Enzyme catalyst
- Catalytic promoters
- Catalytic poisons

TYPES OF CATALYSIS

Two Types

- Homogeneous catalysis
- Heterogeneous catalysis

Homogeneous catalysis: Reactants, catalyst and products- same phase.

Heterogeneous catalysis: Reactants, catalyst and products- different phase.

Enzymes

An **enzyme** is a substance that acts as a catalyst in living organisms, regulating the rate at which chemical reactions proceed without itself being altered in the process. The biological processes that occur within all living organisms are chemical reactions, and most are regulated by **enzymes**.

INDUSTRIAL APPLICATIONS OF CATALYST

Process	Catalyst
1. Haber's process for the manufacture of ammonia $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	Finely divided iron, molybdenum as promoter; conditions: 200 bar pressure and 723-773K temp-erature. Now-a-days, a mixture of iron oxide, potassium oxide and alumina is used.
2. Ostwald's process for the manufacture of nitric acid. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $4NO_2(g) + 2H_2O(l) + O_2(g) \rightarrow 4HNO_3(aq)$	Platinised asbestos; temperature 573K.
3. Contact process for the manufacture of sulphuric acid. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $SO_3(g) + H_2SO_4(aq) \rightarrow \underset{\text{oleum}}{H_2S_2O_7(l)}$ $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(aq)$	Platinised asbestos or vanadium pentoxide (V_2O_5); temperature 673-723K.

www.ncert.nic.in/NCERTS/l/lech105.pdf