

## Fermi Energy and Fermi Level

### Why in news?

More research in quantum physics in recent times have shown that the fermi energy are significant and produce high energy.

### What is fermi energy?

- Fermi energy is defined as the highest occupied energy level of a material at absolute zero temperature ( $-273^{\circ}\text{C}$  or  $0\text{K}$ ).
- In other words, all electrons in a body occupy energy states at or below that body's Fermi energy at  $0\text{K}$ .
- It is an energy difference of the kinetic energy of a system containing fermions.
- Fermi energy is constant for each solid.

### What are fermions?

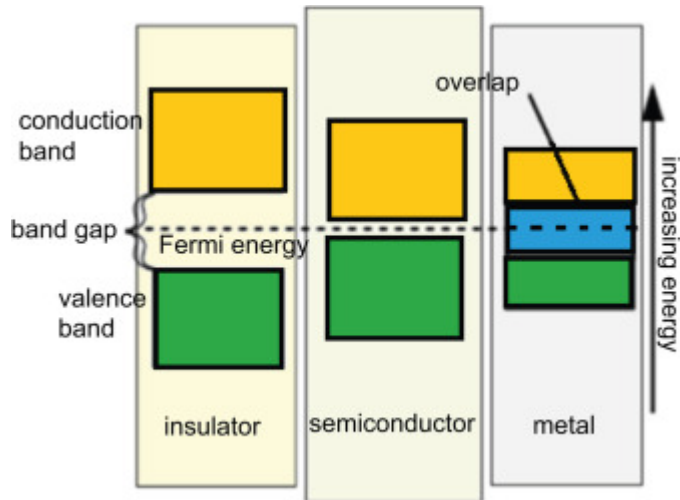
- Fermion is any member of a group of subatomic particles having odd half-integral angular momentum (spin  $1/2$ ,  $3/2$ ).
- Fermions mainly include quarks and leptons along with electrons, protons, and neutrons.
- Fermions obey **Fermi-Dirac statistics**, which means that when one swaps two fermions, the wave function of the system changes sign.
- Fermions obey the **Pauli exclusion principle** - no two fermions can exist in the same quantum state at the same time.

Fermions		Bosons	
Leptons and Quarks	Spin = $\frac{1}{2}$	Spin = $1^*$	Force Carrier Particles
Baryons (qqq)	Spin = $\frac{1}{2}$ $\frac{3}{2}, \frac{5}{2} \dots$	Spin = 0, 1, 2...	Mesons ( $q\bar{q}$ )

### What is fermi level?

- Fermi level is the measure of the energy of the least tightly held electrons within a solid.
- It is the surface of that sea at absolute zero where no electrons will have enough energy to rise above the surface.

- The fermi energy levels enable us to
  - Calculate the density of electrons
  - Number of holes in the material
  - Relative proportion of holes and density with respect to temperature



### What are the applications of fermi energy?

- Fermi energy is
  - Applied to Determine the electrical and thermal characteristics of solids
  - Important in nuclear physics to understand the stability of white dwarfs
  - Used in semiconductors and insulators
  - Used to describe insulators, metals, and semiconductors

### References

1. [The Hindu | Electrons And Fermi Energy](#)
2. [Britannica | About Fermi Energy And Fermi Level](#)
3. [Hyperphysics | Fermi levels](#)