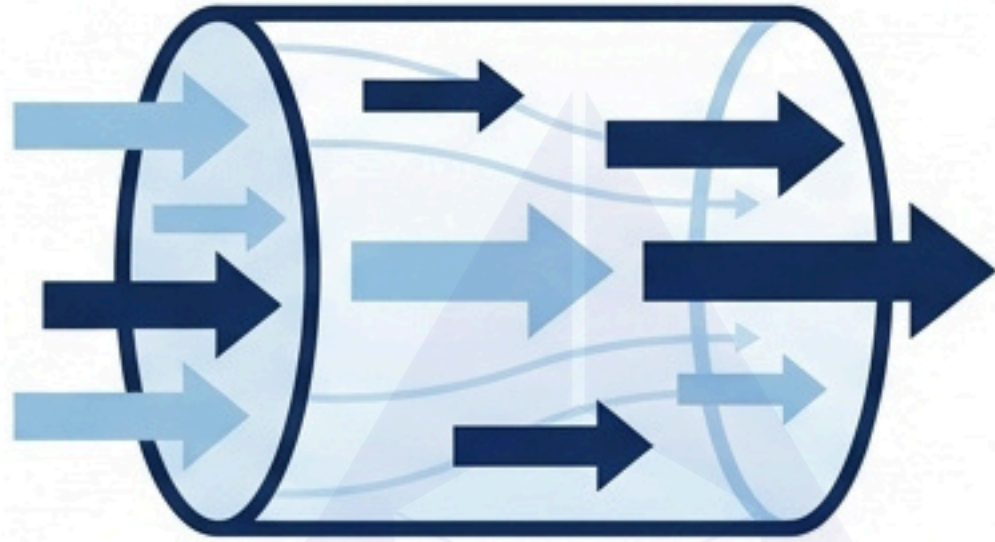


NEET/JEE PHYSICS MASTERCLASS • CHAPTER 14.2

Conductors, Semiconductors and Insulators

Classification of Materials Based on Conductivity

The Two Sides of Electron Flow



Conductivity (σ)

The ease with which electric charge flows through a given material.

Unit: S m^{-1} (Siemens per meter)

$$\rho = 1/\sigma$$



Resistivity (ρ)

The fundamental internal opposition a material presents to the flow of charge.

Unit: $\Omega \text{ m}$ (Ohm-meter)

The Conductivity Spectrum

Metals (Conductors)



Easy current flow

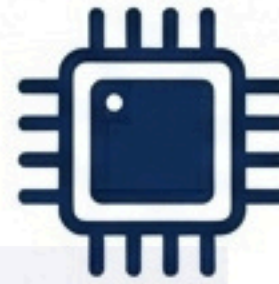


Relative Flow Meter

Resistivity (ρ) $\sim 10^{-2}$ to $10^{-8} \Omega \text{ m}$

Conductivity (σ) $\sim 10^2$ to 10^8 S m^{-1}

Semiconductors



Controlled moderate flow



Relative Flow Meter

Resistivity (ρ) $\sim 10^{-5}$ to $10^6 \Omega \text{ m}$

Conductivity (σ) $\sim 10^5$ to 10^{-6} S m^{-1}

Insulators



Blocked flow



Relative Flow Meter

Resistivity (ρ) $\sim 10^{11}$ to $10^{19} \Omega \text{ m}$

Conductivity (σ) $\sim 10^{-11}$ to $10^{-19} \text{ S m}^{-1}$



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$$E=mc^2$$



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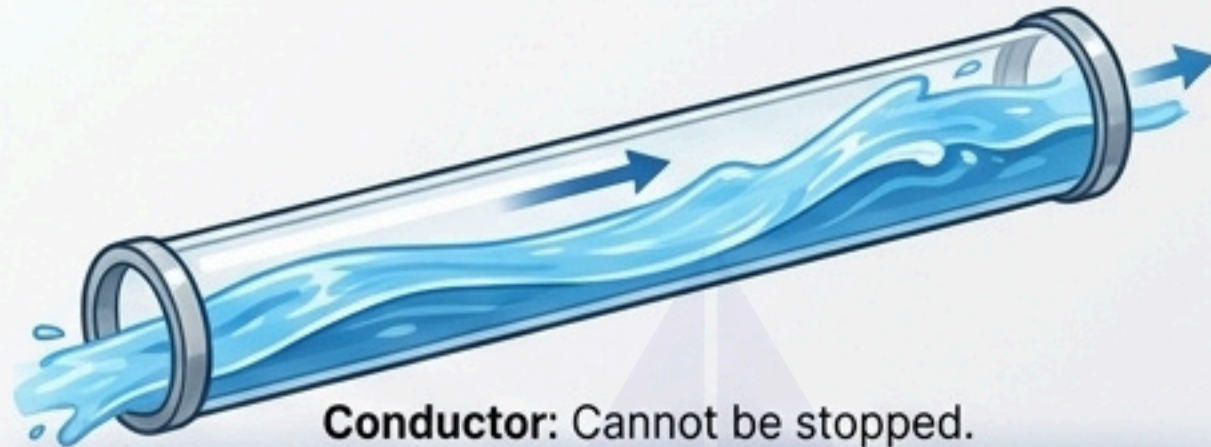
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H1: The Power of the Middle



Why Intermediate Resistivity Matters

Having “middle” conductivity is not a flaw; it is a feature. It means the material's electrical flow is not locked into a permanent state.

Because semiconductors sit in the middle of the spectrum, their conductivity can be dynamically controlled and altered through external excitations—like changes in temperature, light exposure, or applied voltage. This precise tunability is the fundamental basis for all solid-state electronic devices.

Key Takeaways

- 1** Conductivity and resistivity are inverse metrics ($\rho = 1/\sigma$) that dictate a material's electrical classification.
- 2** Metals possess ultra-low resistivity (down to $10^{-8} \Omega \text{ m}$), while Insulators possess massive resistivity (up to $10^{19} \Omega \text{ m}$).
- 3** Semiconductors occupy the intermediate range, providing the crucial ability to control and tune electron flow for modern electronic circuits.



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