

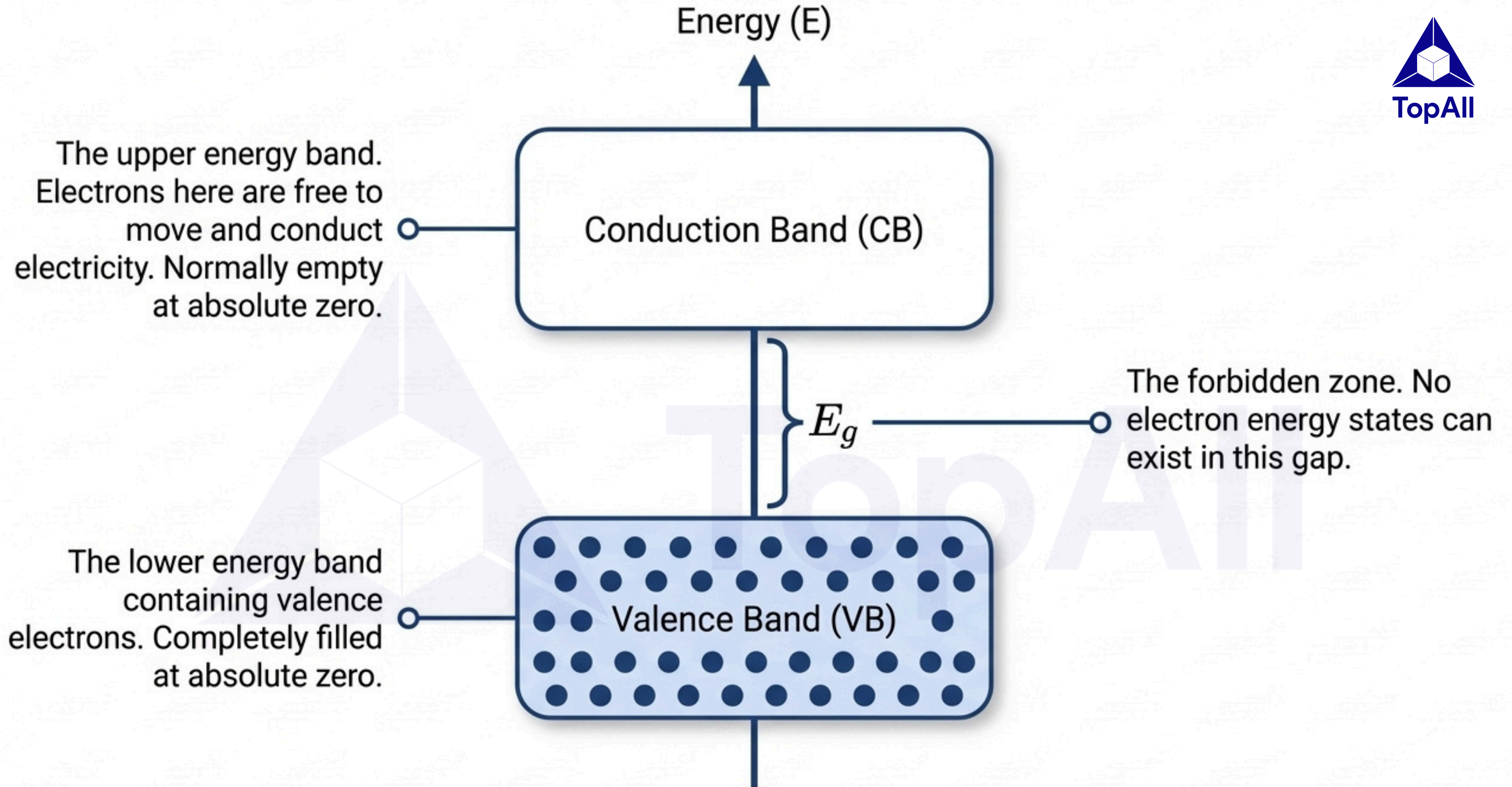


SOLID STATE PHYSICS | EXAM PREP 14.2

Energy Bands and Conductivity

Understanding the fundamental
classification of solids through the
Vertical Energy Ladder framework.





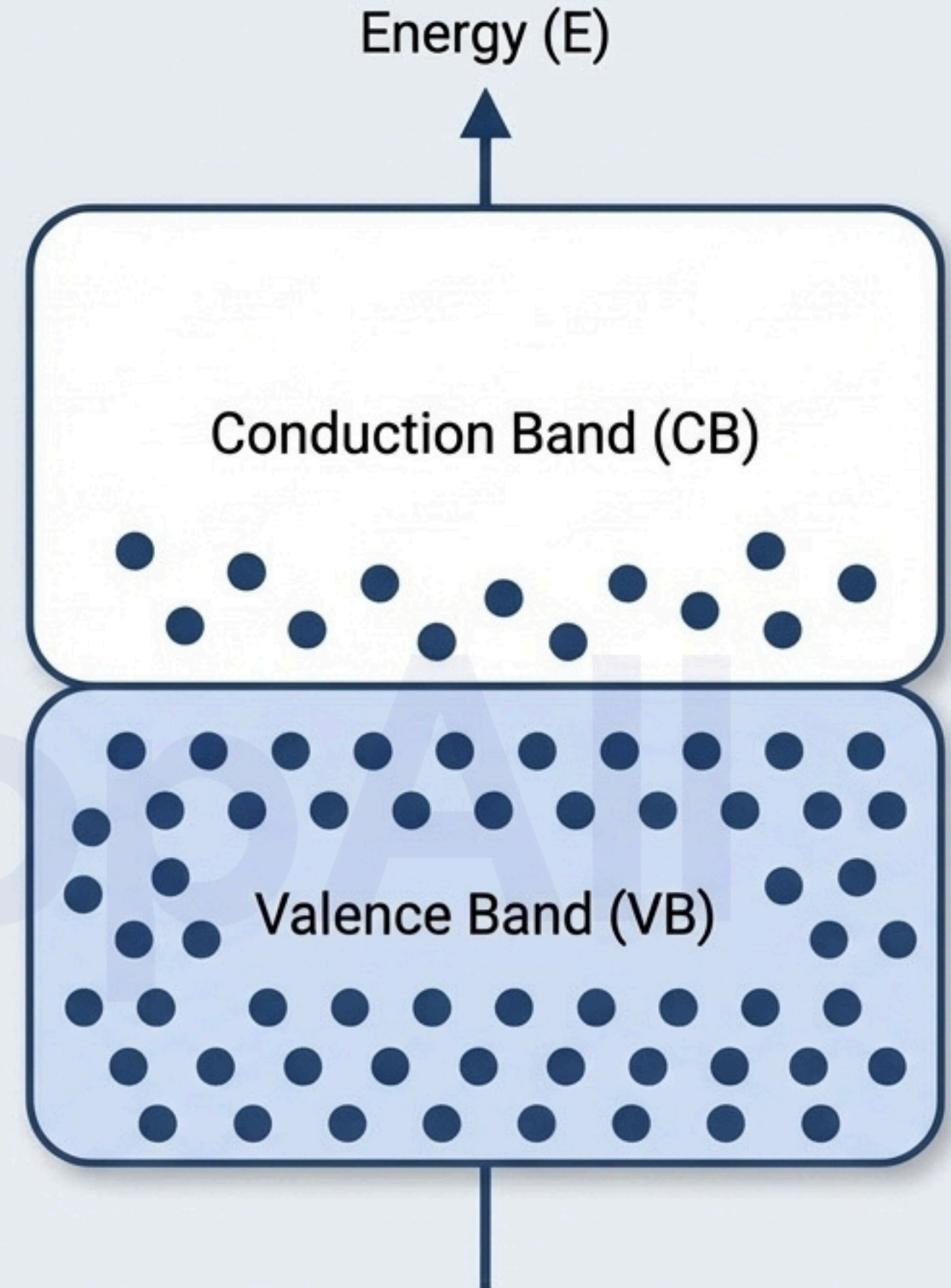


Metals (Conductors)

Overlapping Bands. Electrons from the valence band can easily move into higher energy states within the conduction band. A large number of electrons are always available for electrical conduction.

$$E_g \approx 0 \text{ eV}$$

Ready to conduct.
Resistance is very low.





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$$E=mc^2$$



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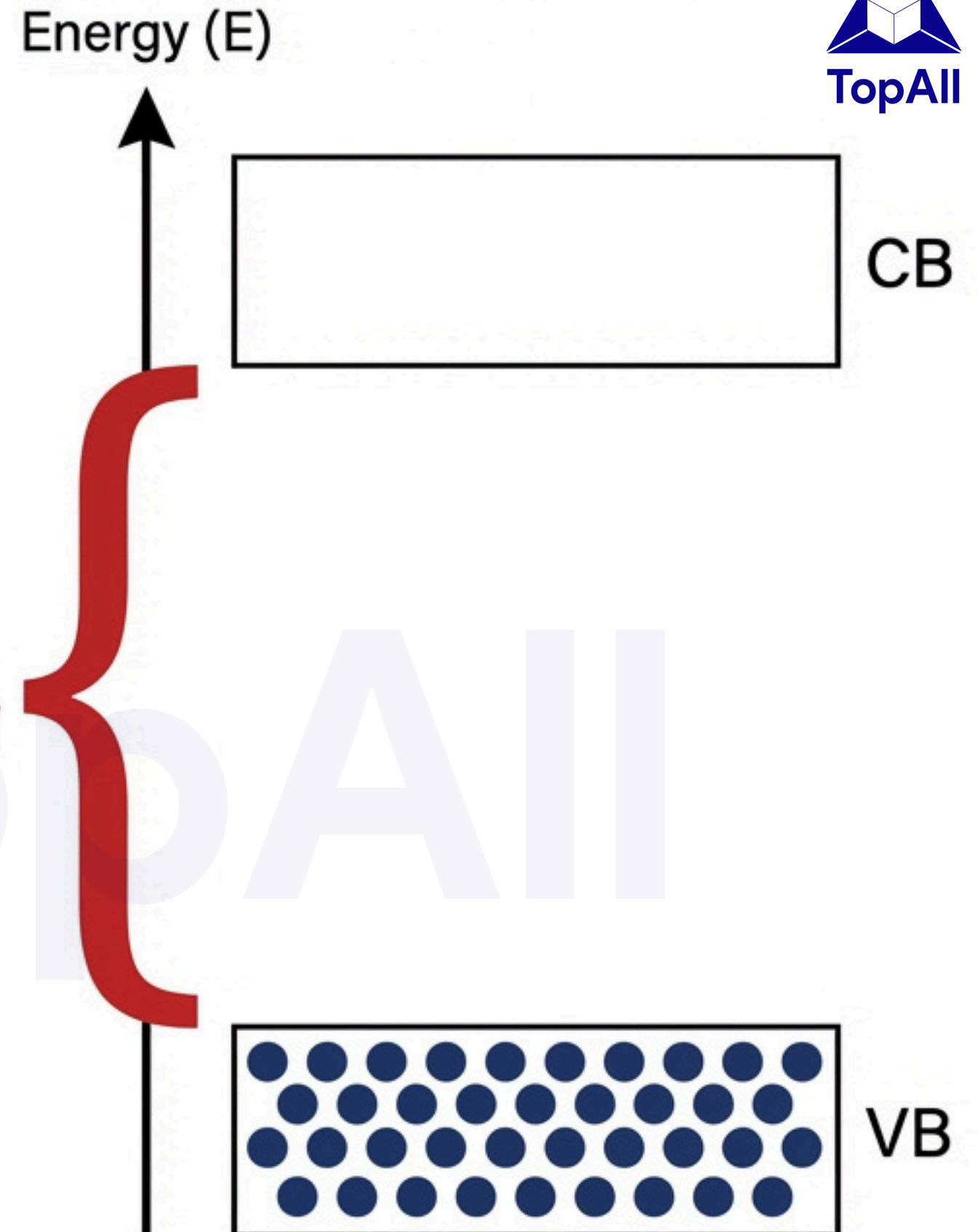


Insulators

The Great Divide. Electrons in the valence band remain tightly bound. The energy gap is so massive that electrons cannot be excited into the conduction band by room-temperature thermal energy.

$$E_g > 3 \text{ eV}$$

Electrons bounded; no thermal excitation possible. Conduction is zero.



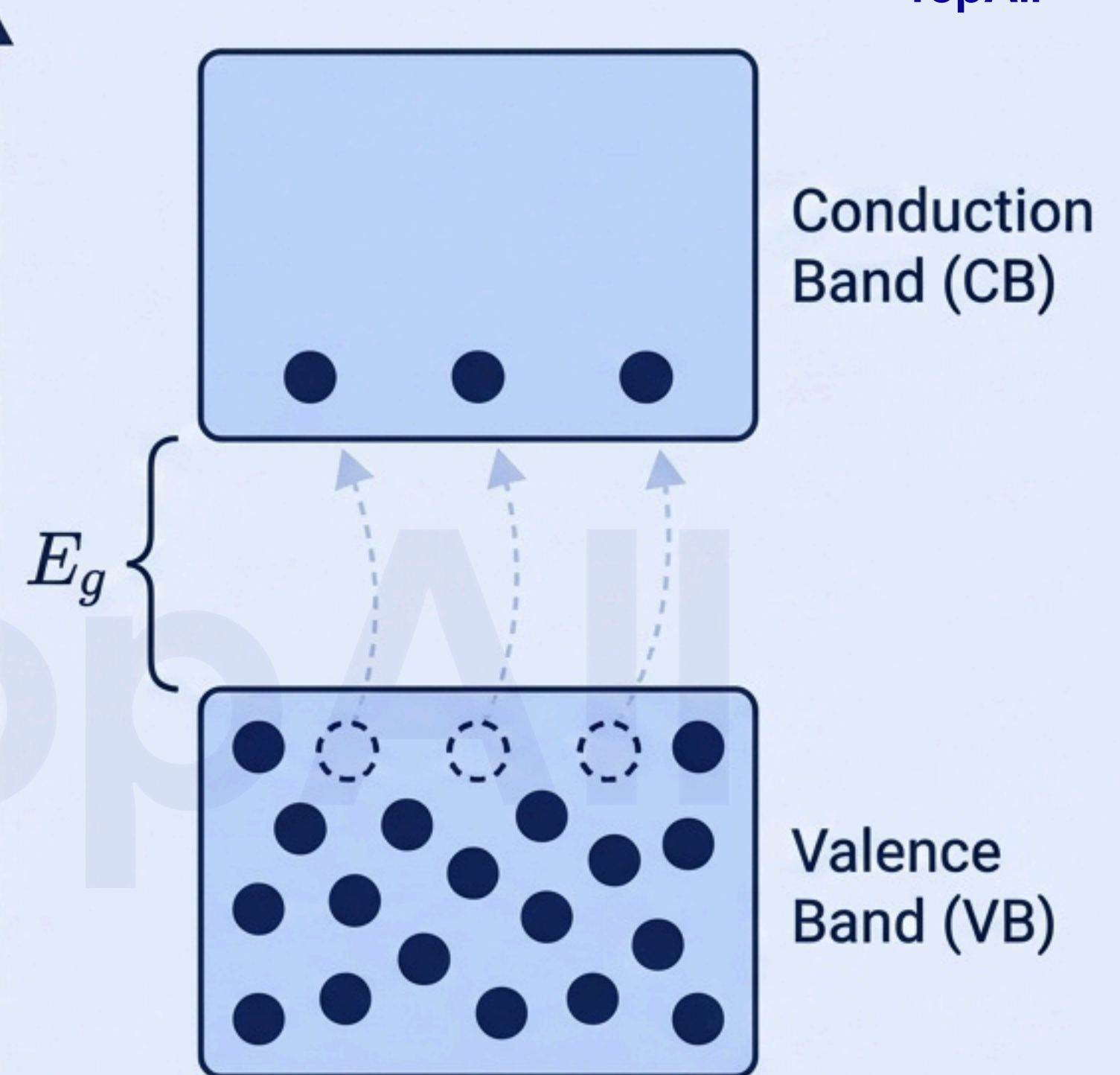
Semiconductors

The Bridgeable Gap. At room temperature, some valence electrons acquire enough thermal energy to cross the small gap. This creates free electrons in the CB and leaves behind positive “holes” in the VB, both of which contribute to conduction.

$$E_g < 3 \text{ eV}$$

Thermal excitation allows limited, dual-carrier conduction.

Energy (E)



	[Column 1] Metals	[Column 2] Semiconductors	[Column 3] Insulators
Band Behavior	Overlapping CB & VB (or partially filled)	Small, finite gap between CB & VB	Large, unbridgeable gap between CB & VB
Energy Gap	$E_g \approx 0 \text{ eV}$	$E_g < 3 \text{ eV}$	$E_g > 3 \text{ eV}$
Conduction at Room Temp	Excellent (Abundant free electrons)	Moderate (Thermally excited electron-hole pairs)	Zero (No free electrons available)



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