

CLASS 11 PHYSICS • CHAPTER 11

The Zeroth Law of Thermodynamics

Understanding Thermal Equilibrium and the Origin of Temperature.

A step-by-step visual guide to the foundational law of thermodynamics.



The Experimental Components

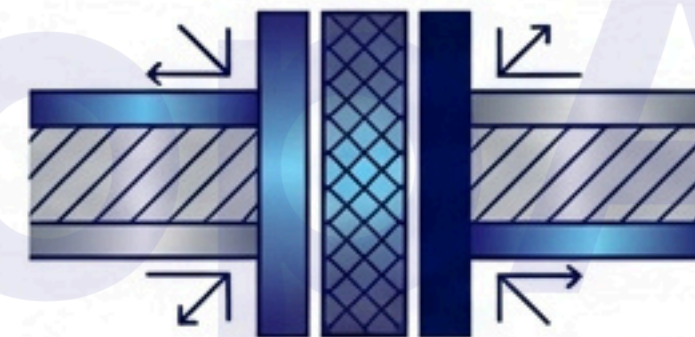
To understand the Zeroth Law, we imagine three distinct macroscopic systems (A, B, and C) separated by two specific types of boundaries:

ADIABATIC WALL

An insulating wall. It does not allow the flow of heat energy between systems.

DIATHERMIC WALL

A conducting wall. It allows heat energy to flow until thermal equilibrium is reached.



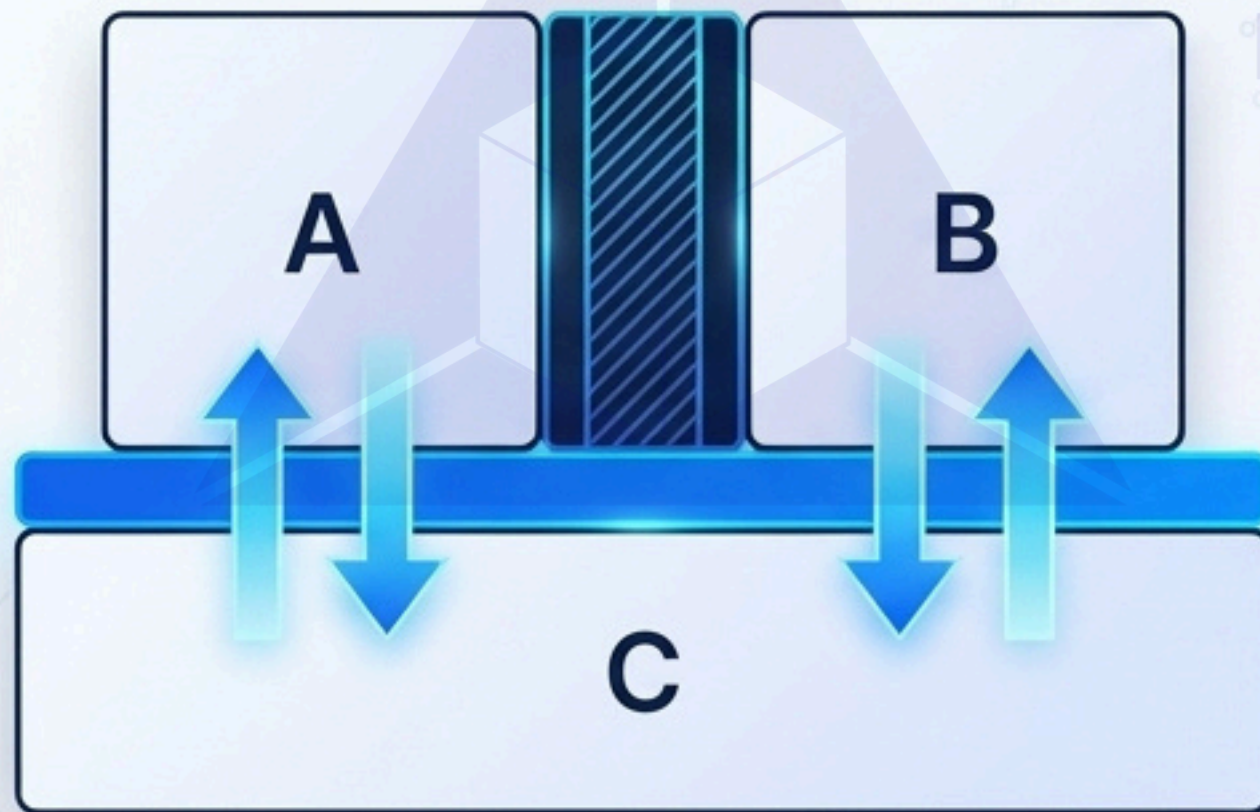
Adiabatic (Blocked)



Diathermic (Flowing)

Systems A and B contact System C

FIG. 11.2(A) REDRAW



- ✓ A and B are separated by an adiabatic (insulating) wall.
- ✓ Both A and B are in contact with System C via a diathermic (conducting) wall.
- ✓ Result: The macroscopic variables of A and B change until they both reach thermal equilibrium with C separately.



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$$E=mc^2$$



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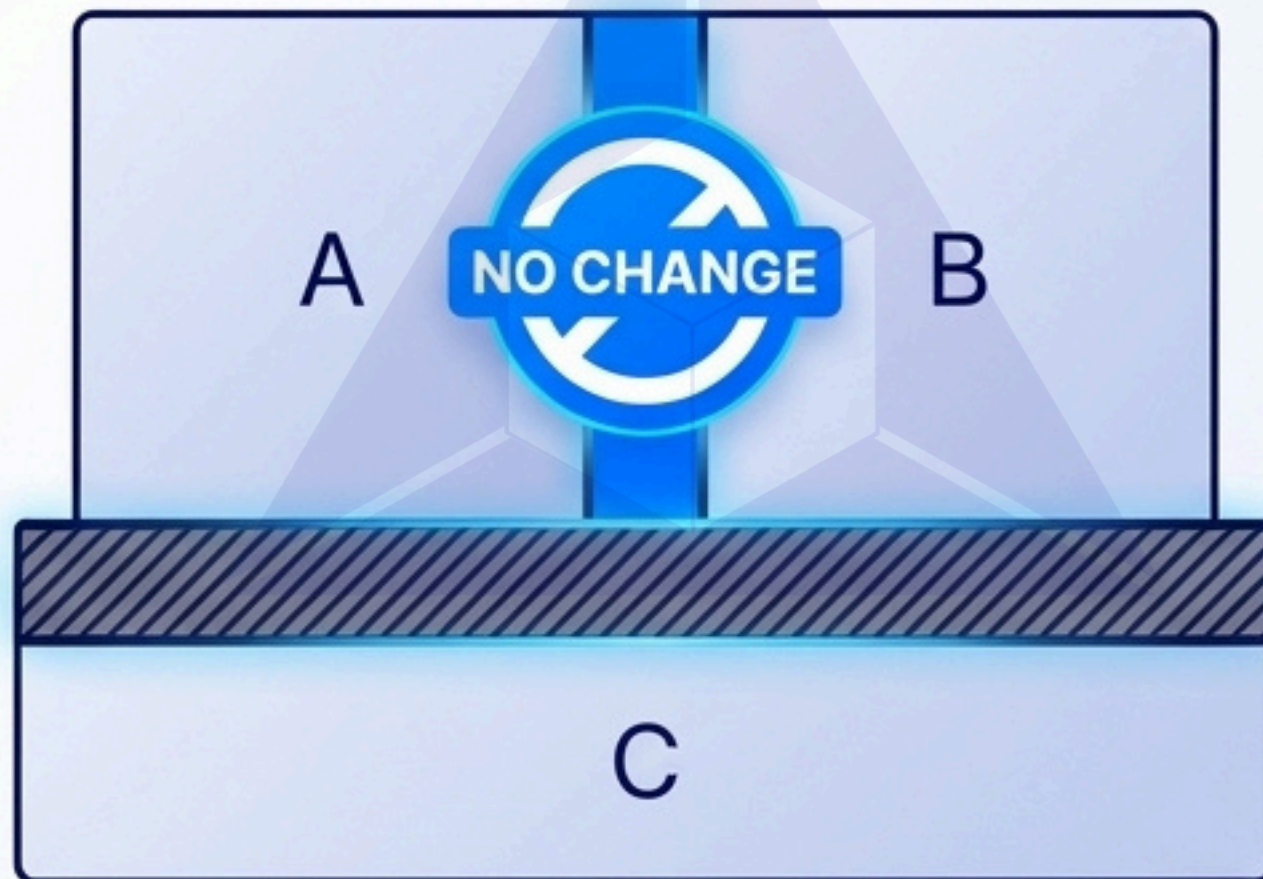
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Systems A and B interact

FIG. 11.2(B) REDRAW



- The walls are swapped: A and B are now connected by a conducting wall, but insulated from C.
- **Crucial Observation:** The states of A and B do not change any further.
- **Conclusion:** They are already in thermal equilibrium with each other!

The Zeroth Law of Thermodynamics

Two systems in thermal equilibrium with a third system separately are in thermal equilibrium with each other.

Formulated by R.H. Fowler in 1931. Named the 'Zeroth' law because it forms the logical foundation for the previously established 1st and 2nd Laws.

How do we define Temperature?

The Zeroth Law proves that when systems are in thermal equilibrium, **they share a common physical quantity. We call this thermodynamic variable Temperature (T).**



If A is in equilibrium with C:

$$T_A = T_C$$

If B is in equilibrium with C:

$$T_B = T_C$$

Therefore:

$$T_A = T_B$$

(A and B are in equilibrium)

KEY TAKEAWAYS

Chapter 11.3 Wrap-Up

- ✓ **Thermal Equilibrium:** State where macroscopic variables do not change over time.
- ✓ **The Zeroth Law:** If A & B are in equilibrium with C, they are in equilibrium with each other.
- ✓ **The Foundation of Temperature:** The law proves the existence of a shared variable (Temperature, T) between systems in equilibrium.

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