SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai

DEPARTMENT OF RADIOGRAPHY TECHNOLOGY

COURSE NAME: GENERAL PHYSICS

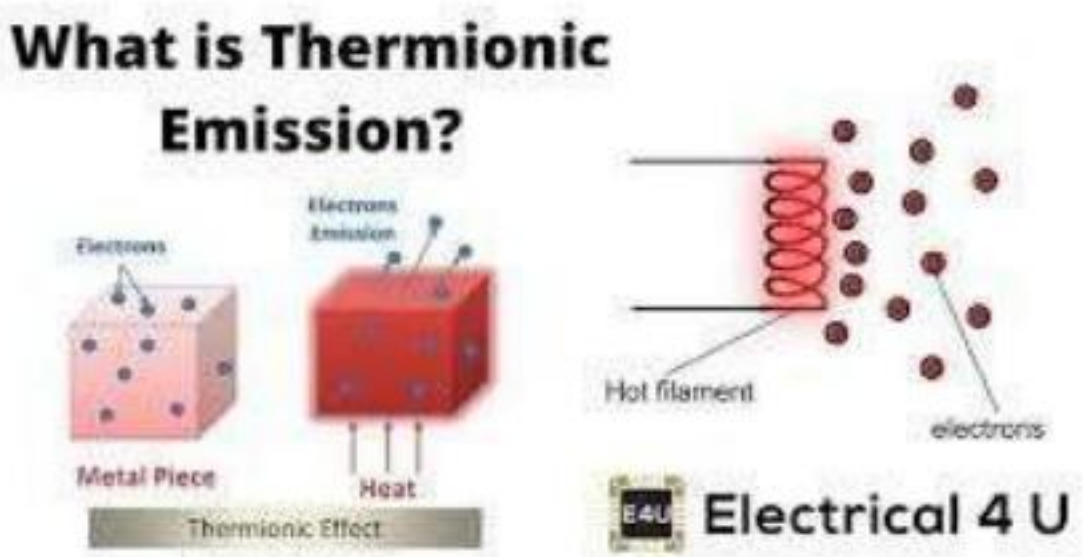
UNIT : 5PHYSICS OF DIAGONESTIC RADIOLOGY

TOPIC :THERMIONIC DIODE

FACULTY NAME: MS.M.DHANALAKSHMI

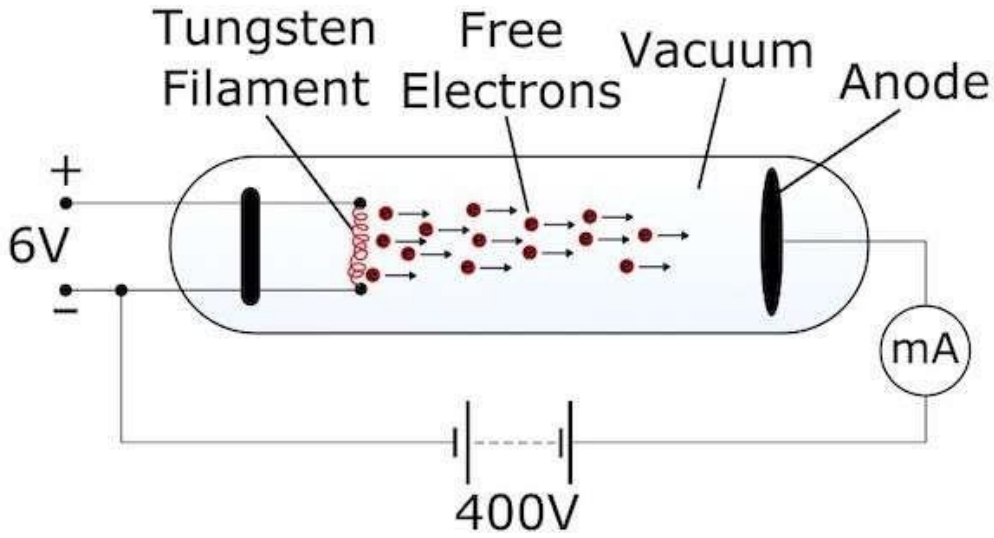
THERMIONIC DIODE – INTRODUCTION{define}

- Thermionic diode is a vacuum tube with cathode and anode.
- Allows current in one direction only (unidirectional).
- Works on thermionic emission of electrons.
- Invented by John Ambrose Fleming (1904).
- Used in early rectifiers and X-ray machines



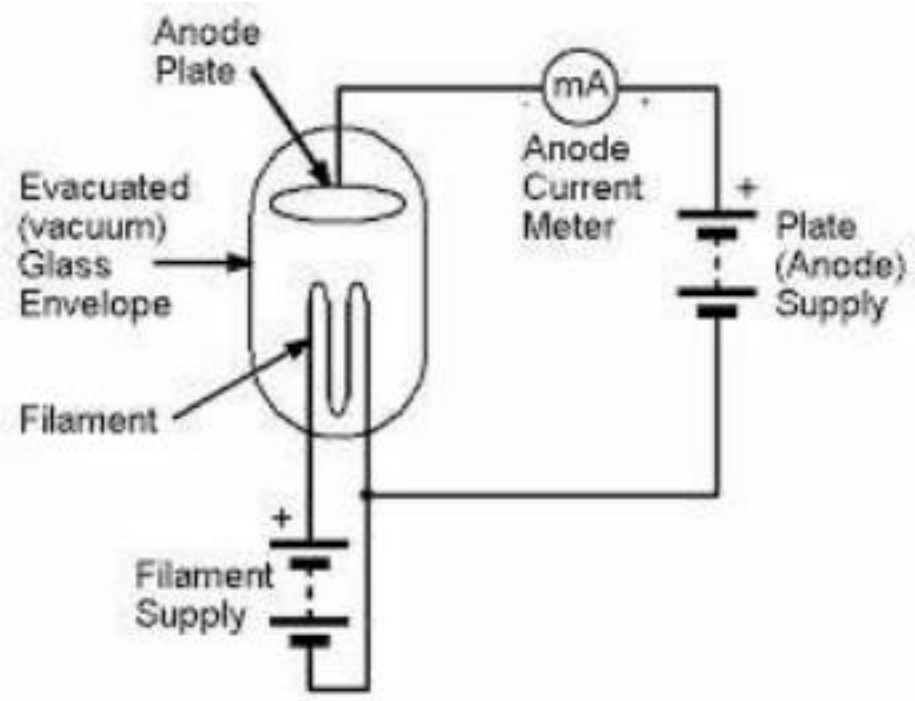
THERMIONIC EMISSION

- Heating cathode (filament) emits electrons (Edison effect).
- Cathode made of tungsten or thoriated tungsten.
- Temperature: 2200–2500 K for emission.
- Electrons form space charge near cathode.
- Emission follows Richardson's law: $J = A T^2 e^{(-\varphi/kT)}$



CONSTRUCTION OF THERMIONIC DIODE

- Evacuated glass/metal envelope (vacuum ~10^{-6} mmHg).
- Cathode: Heated filament (direct/indirect heating).
- Anode: Metal plate (molybdenum/copper).
- High voltage (kV) between anode and cathode.
- No gas inside – prevents ionization

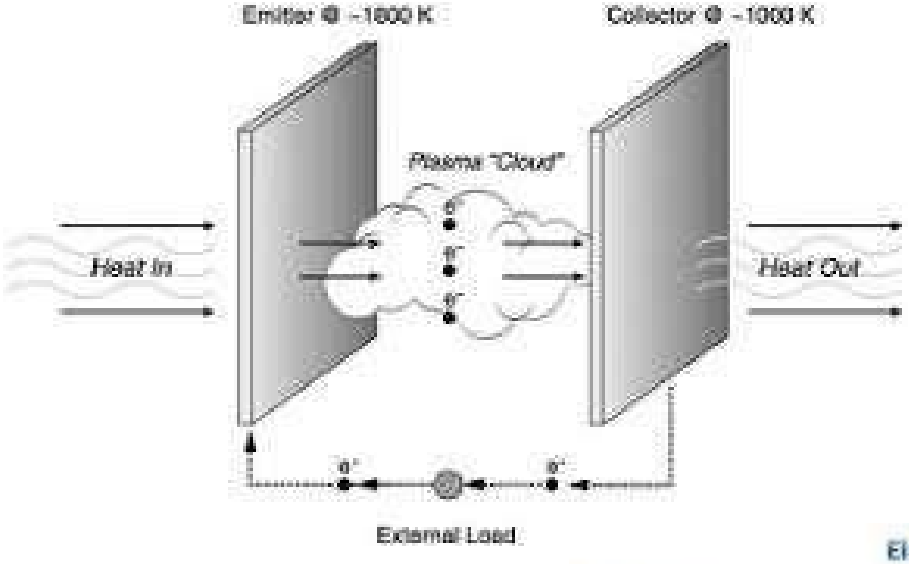


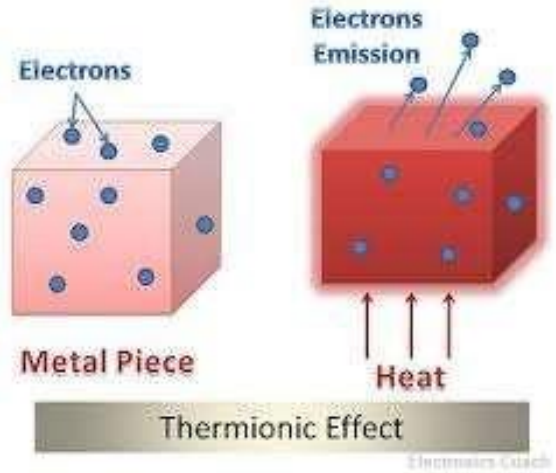
WORKING PRINCIPLE

- Cathode heated → electrons emitted → cloud forms.
- Positive anode attracts electrons → current flows (anode →

cathode externally).

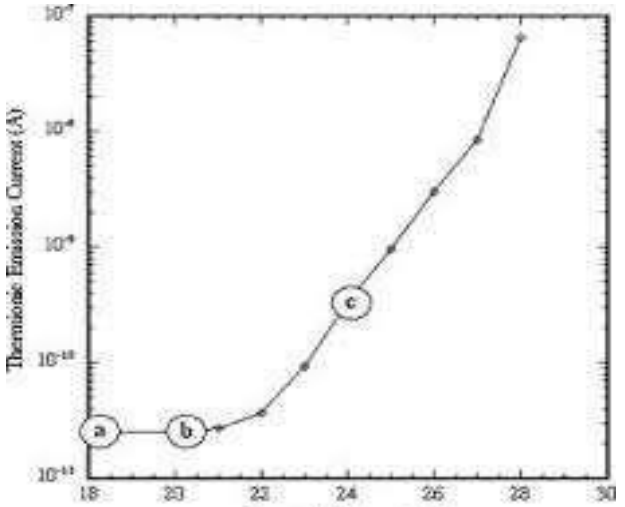
- If anode negative → electrons repelled → no current.
- Acts as rectifier: AC → pulsating DC.
- Cut-off voltage depends on space charge.

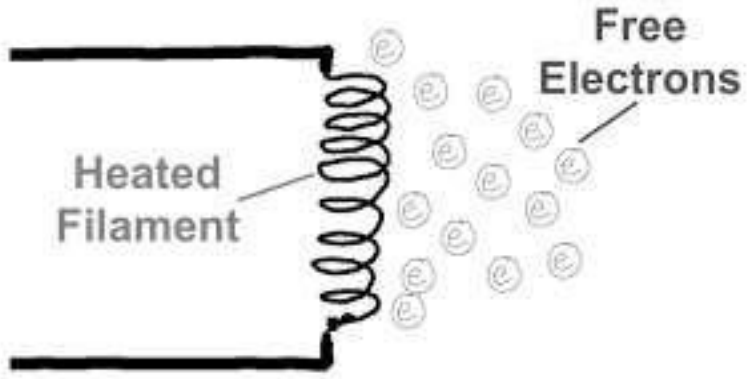




CHARACTERISTICS

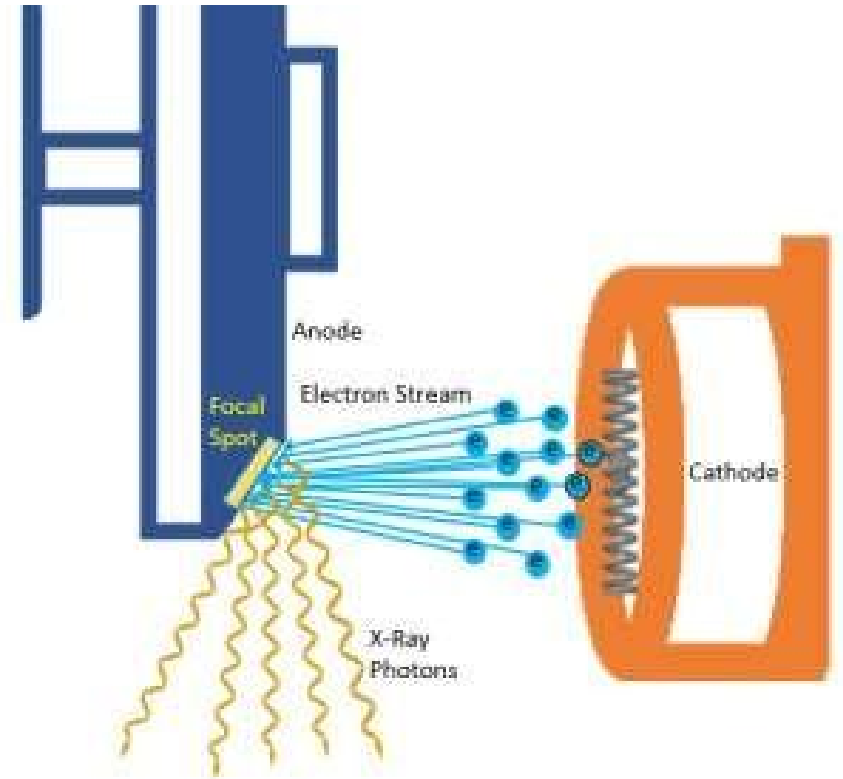
- Anode voltage (Va) vs anode current (Ia) curve.
- At low Va: current limited by space charge.
- Saturation region: all emitted electrons collected.
- Reverse bias: Ia ≈ 0 (no conduction).
- Graph: exponential rise → plateau.





APPLICATIONS IN RADIOLOGY

- Used in early X-ray generators for rectification.
- Converts AC to DC for high-voltage supply.
- Replaced by solid-state diodes in modern machines.
- Still studied for historical & conceptual understanding.
- Demonstrates electron emission in X-ray tubes.

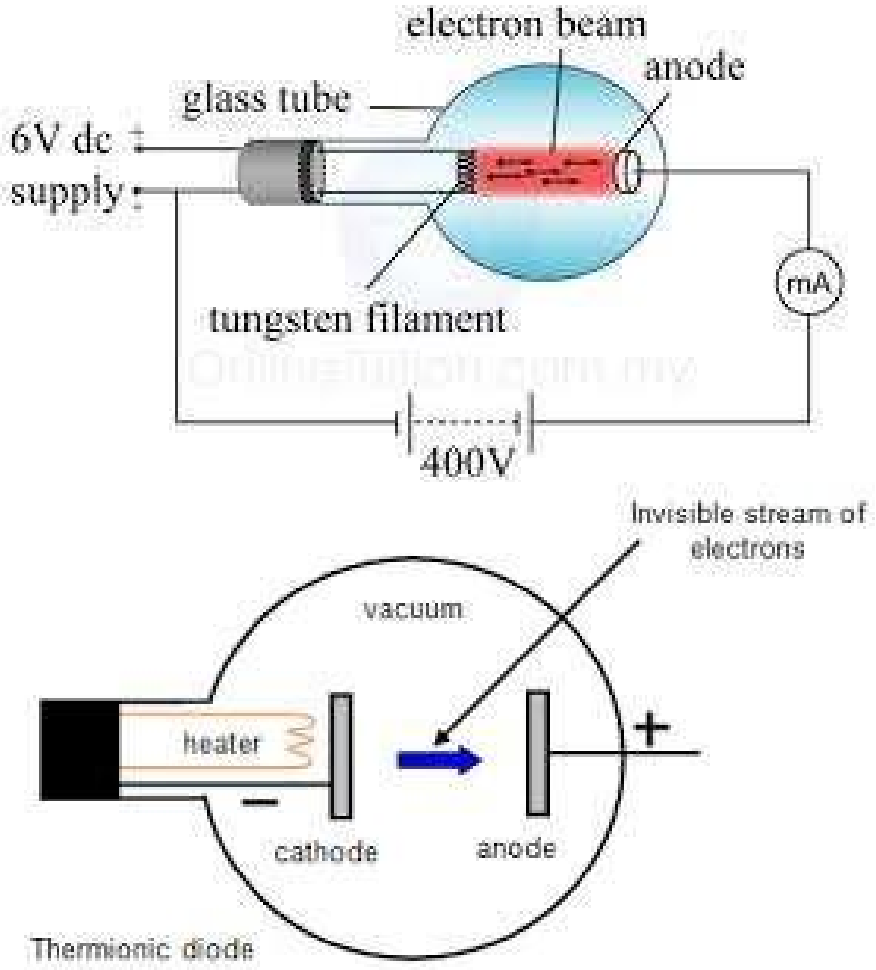


ADVANTAGES & LIMITATIONS

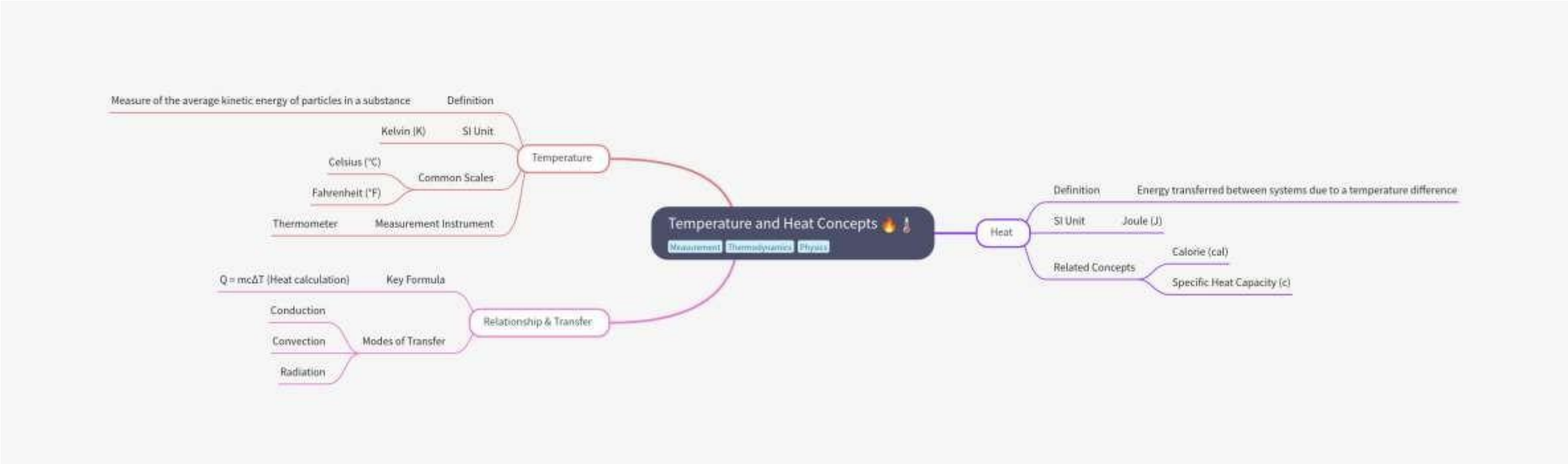
- High voltage handling capacity (kV range).
- Simple construction, robust.
- Unidirectional current flow.
- Limitations: Fragile, high power loss, slow.
- Obsolete in modern digital systems.

COMPARISON WITH X-RAY TUBE

- Both use thermionic emission from heated cathode.
- Diode: 2 electrodes; X-ray tube: cathode + rotating anode.
- Diode: rectification; X-ray tube: X-ray production.
- Both require vacuum and high voltage.
- Foundation for understanding X-ray tube physics.



SUMMARY


Temperature and Heat Concepts
Measurement
Thermodynamics
Physics
Temperature
Definition
Measure of the average kinetic energy of particles in a substance
SI Unit
Kelvin (K)
Common Scales
Celsius (°C)
Fahrenheit (°F)
Measurement Instrument
Thermometer
Heat
Definition
Energy transferred between systems due to a temperature difference
SI Unit
Joule (J)
Related Concepts
Calorie (cal)
Specific Heat Capacity (c)
Relationship & Transfer
Key Formula
Q = mcΔT (Heat calculation)
Modes of Transfer
Conduction
Convection
Radiation

REFERENCE

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3.Christensen's Physics of Diagnostic Radiology

•**Authors:** Thomas S. Curry III, James E. Dowdey, Robert C. Murry Jr.

•**Publisher:** Lippincott Williams & Wilkins (4th Edition, 1990)