TOPIC 9 Transfer of Thermal Energy

Objectives

Candidates should be able to:

(a) show understanding that thermal energy is transferred from a region of higher temperature to a region of lower temperature
(b) describe, in molecular terms, how energy transfer occurs in solids
(c) describe, in terms of density changes, convection in fluids
(d) explain that energy transfer of a body by radiation does not require a material medium and the rate of energy transfer is affected by:
  (i) colour and texture of the surface
  (ii) surface temperature
  (iii) surface area
(e) apply the concept of thermal energy transfer to everyday applications

NOTES.....

9.1 Types of Heat Transfer

1. 3 types of heat transfer: Conduction, Convection, Radiation
2. Transfer of thermal energy is ***always*** from a high temperature region to a low temperature region (Temperature gradient).

	Conduction	Convection	Radiation
Medium	Solids Liquids Gases	Liquids (fluid) Gases (fluid)	Vacuum*
Process	1. Vibration of atoms/ molecules 2. Movement of free electrons (if any, i.e. metals) For solids, their atoms/molecules are in fixed positions	Movement of atoms/ molecules in the form of convection by currents set up by density change in parts of the fluid being heated.	Infrared waves (no medium required)

* Radiation does not require matter to transfer heat, but radiation can travel through matter (through several thousands of metres in air or a few metres in common solids).

9.2 Conduction

1. A direct contact between media is necessary.
2. Metals are the best solid conductors because of their free electrons.
3. Liquids and gases are poor conductors because their molecules are not closely packed together in fixed positions like solids.
4. Application: Use metals to make cooking utensils.

9.3 Convection

1. Molecules/ atoms must be free to move.
2. Set-up of a convection current: The fluid closer to the heat source expands, and its density decreases and the surrounding denser fluid displaces it.
3. Application: Air conditioners are placed near the ceiling because cold air, being denser, will sink to displace the warm air in the room.

9.4 Radiation

1. Factors affecting radiation:
   (a) Colour
   (b) Roughness
   (c) Area exposed to radiation
2. Good radiator/ good absorber of radiation: black, dull surface, with a huge amount of surface area exposed.
3. Poor radiator/ poor absorber of radiation: bright, shiny and polished surface.
4. Application: Greenhouses for growing plants.

9.5 Vacuum Flask

1. Reduces heat transfer in or out through conduction, convection and radiation.
2. Can store and maintain temperature (either hot or cold) of the contents in the flask.

Type of heat transfer	How heat transfer is reduced
Convection	Vacuum between the double glass walls.
Conduction	Vacuum between the double glass walls. Insulated cover and stopper.
Radiation	Shiny silvered inner surface of the glass walls.