O Level Physics
Unit 10: Transfer of Thermal Energy

Transfer of Thermal Energy

1) Transfer of thermal energy takes place when there is a temperature difference. Thermal energy is transferred from a hotter region to a colder region.

2) When 2 bodies are at the same temperature, there is no net flow of thermal energy between then and they are said to be in thermal equilibrium.

Conduction

3) Conduction is the transfer of thermal energy without the material medium moving.

4)

Modes of Conduction in solids	
Non-metals	**Metals**
1) Molecular vibrations When heat is supplied, thermal energy is converted into kinetic energy, causing the particles to vibrate more vigorously. This results in collisions with the neighbouring less energetic particles, forcing them to vibrate more vigorously as well. This transfer of kinetic energy causes conduction.	1) Molecular vibrations When heat is supplied, thermal energy is converted into kinetic energy, causing the particles to vibrate more vigorously. This results in collisions with the neighbouring less energetic particles, forcing them to vibrate more vigorously as well. This transfer of kinetic energy causes conduction.
	2) Free electron diffusion When metals are heated, the free electrons gain kinetic energy. As they diffuse into the cooler regions of the metal, they collide with atoms and transfer their kinetic energy to them. Thus, metals conduct thermal energy faster than insulators.

5) Solids are better conductors of heat than liquids and gases. This is because collisions between molecules are less frequent in liquids as they are spaced further apart. Thus, the transfer of kinetic energy from energetic molecules to neighbouring molecules is slower compared to solids.

Convection

6) Convection is the transfer of thermal energy through currents in fluids.

7) Convection current is the movement of fluids caused by density changes in various parts of the fluid.

8)

Ways of setting up a Convection Current	
Heating the bottom of a flask of fluid	**Cooling the top of a flask of fluid**
When a flask of fluid is heated from the bottom, water at the bottom expands. With this increase in volume, it becomes less dense than the surrounding water and rises. Meanwhile, the cool water in the upper part of the flask, being denser, sinks to replace the risen less dense water. This sets up convection current.	When a flask of fluid is cooled from the top, water at the top contracts. With this decrease in volume, it becomes denser than the surrounding water and sinks to the bottom. The denser water will occupy the space of the less dense water and pushes it away. The less dense water rises and this sets up convection current.

Radiation

9)   Radiation is the transmission of energy through infrared waves which does not require the aid of a medium.

10) Infrared radiation is absorbed and emitted by all objects and surfaces.

11) Dull black surfaces are better absorbers and emitters of infrared radiation than shiny white surfaces.

12)

Factors affecting rate of radiation	
Factor	**Relationship**
1) Colour/texture of surface	Dull black surfaces are better absorbers and emitters of infrared radiation than shiny white surfaces.
2) Surface temperature	The surface temp of an object relative to the surrounding temp is linearly related to the rate of radiation.
3) Surface area	The surface area of an object is linearly related to the rate of radiation.

Conduction, convection and radiation

13)

Applications of thermal energy transfer			
Conduction		Convection	Radiation
Conductors	Insulators		
Kettle, pans, pots	Insulated handles of utensils and appliances	Electric kettles, water heater systems, air-conditioners	Vacuum flasks, teapots with shiny surfaces

14)

Comparison between 3 methods of heat transfer in different states			
	Conduction	**Convection**	**Radiation**
Solid	✔	✘	✔
Liquid	✔ (Inefficient)	✔	✔
Gas	✔ (Inefficient)	✔	✔
Vacuum	✘	✘	✔

Notes: