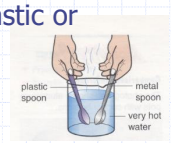
Transfer of Thermal Energy

Thinking Questions

1. Video Demo: Unburned Paper. Is it magic?
2. **Fried Ice Cream**
   - Outer layer: Hot and crisp bread
   - Inside: Unmelted Ice-cream
   - How is it possible?
3. Why do most **stirrers** come in plastic or wooden handles?

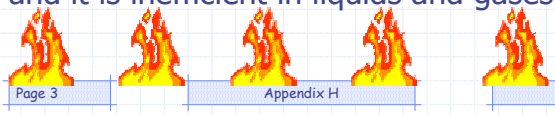


The Answer Lies in

Conduction

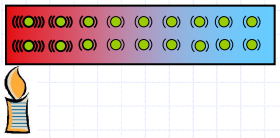
Conduction is the transfer of energy through matter from particle to particle with no net movement.

Conduction occurs mainly in solid, and it is inefficient in liquids and gases

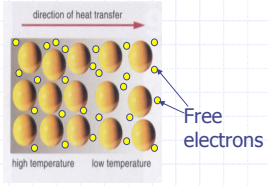


Mechanisms of Conduction

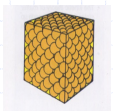
1. **Molecular vibrations**: vigorous vibration and collision of neighboring molecules. Occurs in metal and non-metal → **slow** mechanism



2. **Free Electron Diffusion**: fast moving, energy carrying electrons diffuse or spread into the cooler parts of the metal. Occurs **in metal only** → **fast** mechanism

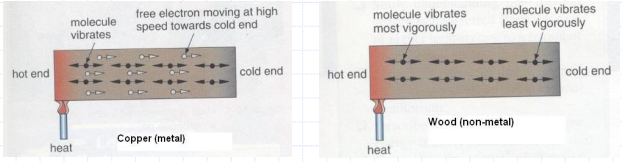


Conduction in Solid



Particles are **close** together, **held tightly** together, not free to move and simply vibrate in **fixed** positions

Metal Vs Non-Metal

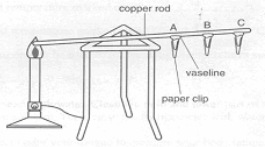


Hence, metal conducts heat better than non-metal

Conduction in Solids (Worksheet)

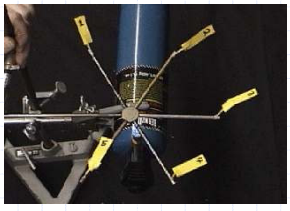
Investigation: Microsoft Word Document

Which clip will fall of first?
Which clip will fall of last?



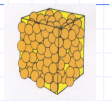
Answer: A → B → C

Video:
Which of these metals conduct heat best? (Arrange from the best to the least)



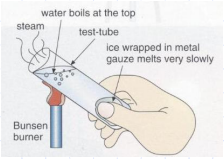
Flag: (1) Steel, (2) Brass, (3) Aluminum, (4) Stainless Steel, (5) Copper

Conduction in Liquids



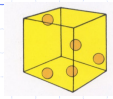
Particles are **close** together, held **less tightly** than those in **solids**, can **roll** over one another

Liquid: e.g. Water



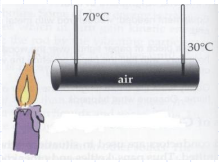
Water is a poor conductor of heat

Conduction in Gases



Particles are much **further apart**, are **not held** together, and can **move** about **freely**

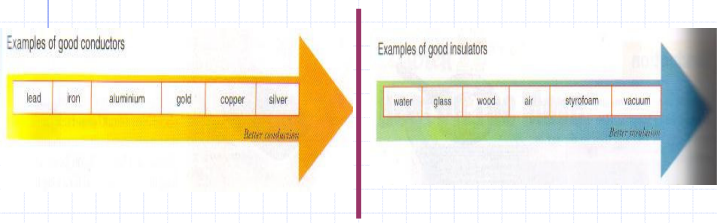
Gases: e.g. Air



Air is a poor conductor of heat

Conductor Vs Insulator

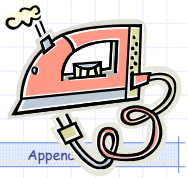
- **Conductor** = Good conducting Materials
- **Insulator** = Poor conducting Materials



Everyday Application of Conduction - Conductor

- ***Cooking Utensils:*** kettles, saucepan made of metal

- ***Soldering iron tip*** is made of copper. Copper conducts heat better than iron.
- ***Electric Iron***



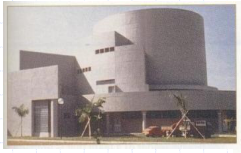
Everyday Application of Conduction - Insulator

- Handle of cooking utensils (Made of wood/plastics)

- Styrofoam food boxes
- Fur or Fat in animals

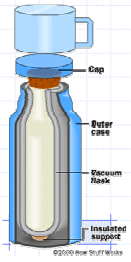
Everyday Application of Conduction - Insulator

- Buildings: The use of Concrete & Double Glazing



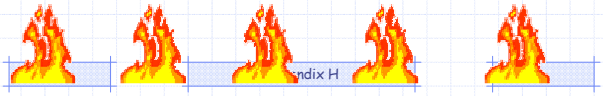
- Oven Gloves: Use of trapped air

- Vacuum Flask

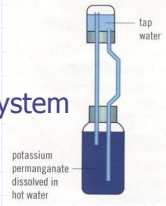


Recap

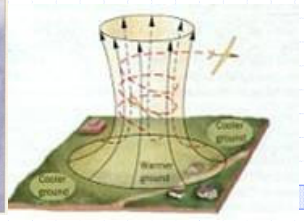
Conduction occurs mainly in solids. Conduction in **liquids** and **gases** is **inefficient**
Energy is transferred through the solid **without** the **solid** itself **moving**
Conduction occurs by either **molecular vibration** or **free electron diffusion** in solids
Conductor = Good conducting material **Insulator** = Poor conducting material



Thinking Questions



- **Demo**: A model hot water system
- **Why** does a hang glider rise?

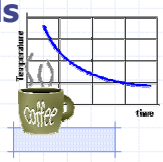


The Answer Lies in

Convection

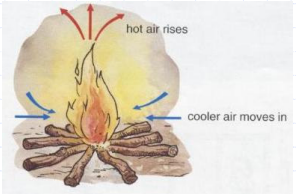
Convection is the transfer of heat through fluids by means of bulk movement of the fluid itself

Convection occurs **only** in **fluids** (i.e. liquids or gases)



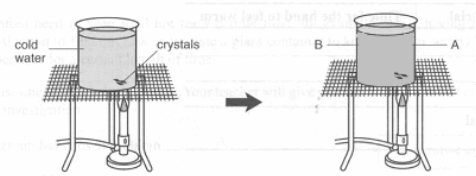
Mechanism of Convection

- By means of **convection current**: the movement of fluid caused by the change in densities in various parts of the fluid



Convection: Worksheet Activities

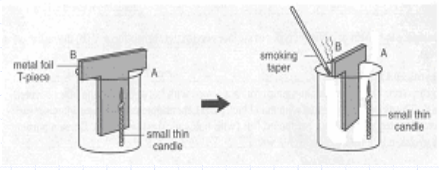
- Convection Current in Water: Appendix C



Answer: The water at A is hotter than B; the water at A rises, and at B falls

Convection: Worksheet Activities

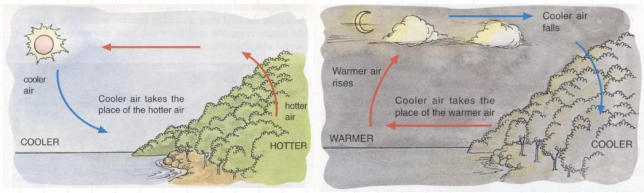
- Convection Current in Gas: Appendix D



Answer: The air at A is hotter than B; the air at A rises, and at B falls

Consequences of Convection

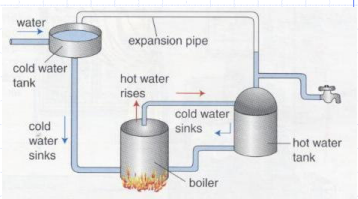
- Formation of sea breeze and land breeze



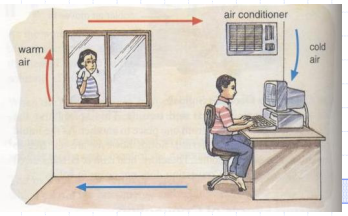
- Animation: sea breeze and land breeze

Everyday Applications of Convection

- Hot-water system

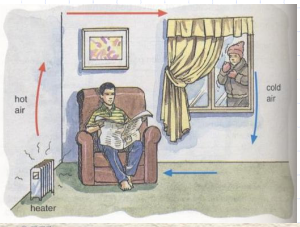


- Air Conditioner

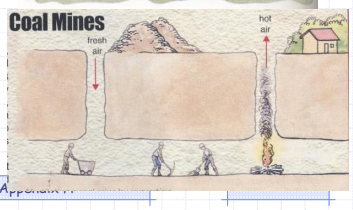


Everyday Applications of Convection

- Warming a room

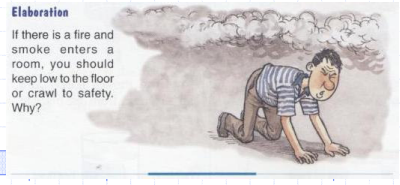


- Ventilation in coal mines



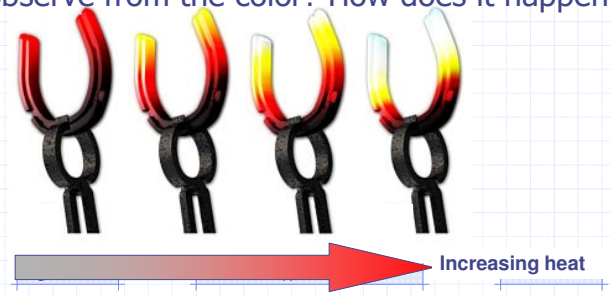
Recap

- **Convection** is the transfer of heat through fluids by means of bulk movement of the fluid itself
- Mechanism: **convection current** (the movement of fluid caused by the change in densities in various parts of the fluid)



Thinking Questions

- Video demo: Radiometer. What do you see?
- As the material gets hotter, what do you observe from the color? How does it happen?



The Answer Lies in

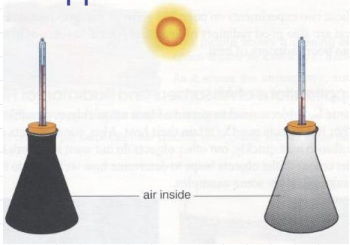
Radiation

Radiation is the continual emission of infra-red waves from the surface of all bodies, transmitted through space, without the aid of a material medium

Radiant heat is heat due to the infra-red waves

Radiation: Worksheet Activity

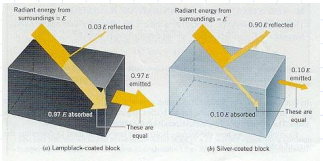
- Radiation: Appendix E



"Black container **absorbs** heat better while white/shiny container **reflects** heat better"

Factors Affecting the Rate of Transfer of Energy by Radiation

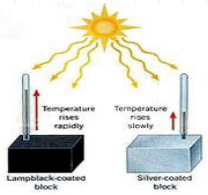
1. **Color and Texture of the Surface**



Dull, black surfaces are **better emitters** of infra-red radiation **than shiny, white surfaces**

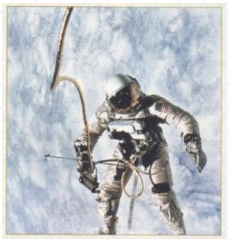
2. **Surface Temperature**

3. **Surface Area**



Consequences of Radiation

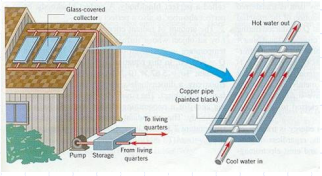
- Color and texture of clothing



- Skin cancer

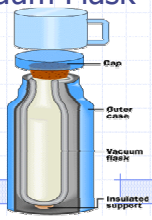
Everyday Applications of Radiation

- Solar water heater



- Shiny Teapots

- Vacuum Flask



Recap

- **Radiation** is the continual ***emission of infra-red waves*** from the ***surface*** of ***all bodies***, transmitted through space, ***without*** the aid of a ***material medium***.
- **Factors affecting** the ***rate*** of transfer of energy by radiation: ***color and texture of surface***, ***surface temperature*** and ***surface area***