

# Transfer of Energy by Heating & its effect.

## ① Temperature

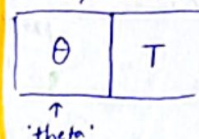
**Definition:** Temperature is the measure of the degree of 'hotness' or 'coldness' of a body.

→ **SI Unit:** Kelvin (K)

→ other units: Celsius ( $^{\circ}\text{C}$ ) or Fahrenheit ( $^{\circ}\text{F}$ )

→ Measuring tool: Thermometer

Symbols:



## ② Transfer of Energy by heating.

→ **Cause:** Temperature difference between two objects.

→ Energy is transferred by heating from a region of higher temperature to a region of lower temperature until both regions reach a **thermal equilibrium**.

### ★ Thermal Equilibrium

↳ a state in which **two or more objects** have the **same temperature** and that there is **no transfer** of energy between them.

### HEATING

Substance is **heated**  
↓  
energy is transferred to particles  
↓  
particles **gain kinetic energy**  
↓  
particles **vibrate more vigorously/faster**  
↓  
grow **further apart** from each other  
↓  
substance **expands**

### COOLING

Substance is **cooled**  
↓  
energy is **transferred out** of substance  
↓  
particles **lose kinetic energy**  
↓  
move **slower/less vigorously**  
↓  
grow **closer** to each other  
↓  
substance **contracts**



|         | MASS | VOLUME | DENSITY |
|---------|------|--------|---------|
| heating | same | ↑      | ↓       |
| cooling | same | ↓      | ↑       |

∴ During **heating** & **cooling**, **Volume** & **Density** of a substance are **INVERSELY PROPORTIONAL**.  
(When one goes up the other one goes down.)

\* ALSO: [Gases > Liquids > Solids] when it comes to **Percentage change in volume**.

### Examples of thermal expansion & contraction

#### → Railway track

↳ hot weather → **expand**  
death ← **derailing**  
∴ **Expansion gaps!**

#### → Coastal Environment:

↳ hot weather → **high tides**  
↓  
**flood & erosion**

∴ **Sea walls!**

#### → Pipes

↳ hot/cold fluids passing  
↓  
pipe **breaks** ← **expand/contract**  
↓  
lack of **possibility** → **serious**  
harmful things  
∴ **Flexible metal pipes w/ bends.**

#### → Bimetallic strip

↳ one side **expands/contracts** faster  
used for **switches & sensors** ← **strip bends**

#### → Hot air balloon

↳ hot air **rises** → **floats**

∴ **Sea walls!**

**Add one**

Solar Panel → **black** → **↑ absorption**

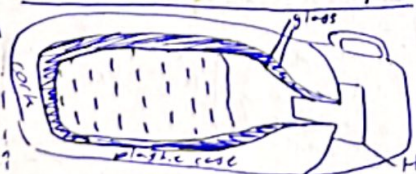
Fridge cooling fin → **white** → **↑ emission**

Applications

Kettle → **white** → **↓ emission**

Fuel storage tank → **white** → **↓ absorption**

### Vacuum Flask Example



**Vacuum**

Mostly hollow/vacuum

Hollow plastic cap

★ **reduces energy transfer** out by **reducing/preventing**:  
→ **conduction** (most)  
→ **convection** (some)  
→ **Radiation** (silvered glass)  
→ **evaporation** (cap)

# ③ Thermal Processes

## ④ Conduction

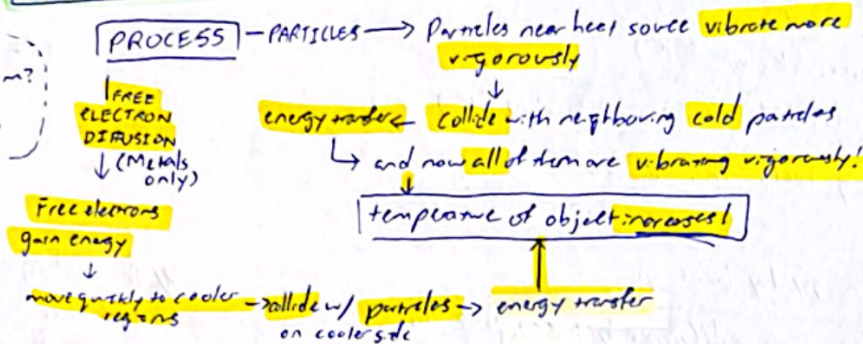
↳ Definition: Conduction is the process of energy transfer where energy is transferred through the passing on of thermal energy from one particle to another.

### Checklist

- Presence of a medium?
- they're in contact?

★ Conduction can't happen in vacuum.

### PROCESS



### Examples

→ Heating one end of a rod and the whole rod gradually heats up

Applications

- Metal for cooking pot → reduce cook time
- Wood for handle → prevent burning hand
- Wool for coats to keep warm
- air pockets → air is slowest for conduction  
 ↳ retain heat

### ★ AFFECTING FACTORS

① State of Matter

| Solid          | Liquid | Gas            |
|----------------|--------|----------------|
| more collision |        | less collision |

### ② Material

Metals → free electron  
 Non metals → free electron  
 no free electrons → vibration of particles

## ③ Convection

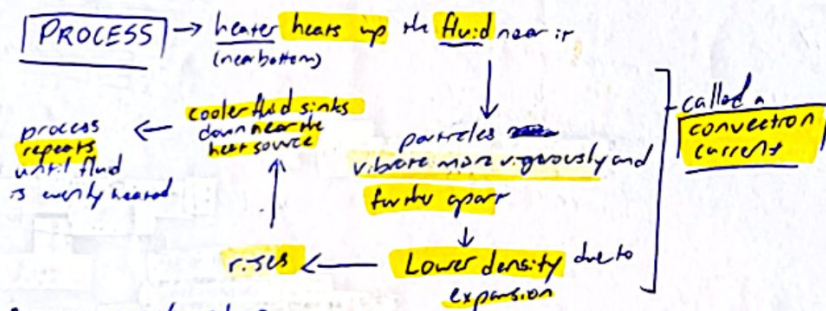
↳ Definition: Convection is the process of energy transfer through a convection current of a fluid, due to a difference in density.

### Checklist

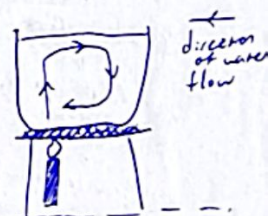
- Fluid? (liquid/gas)
- Difference in Density

★ Heat source should be close to bottom of fluid body.

### PROCESS



### Examples



Applications

- Aircon: near the ceiling
- Heater: near the floor
- cold air sinks

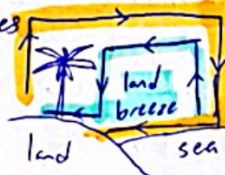
### ★ AFFECTING FACTORS

#### ① State of Matter

Liquid → Gas → more available space for bulk movement  
 ⇒ faster rate of energy transfer

### ★ Coastal Breezes

- night time
- day time



Day → hot air rise from land  
 ↓  
 cooler air comes in  
 Night: other way

## ③ Radiation

↳ Definition: Radiation is the process of energy transfer through electromagnetic waves and does not require a medium.

### Checklist

- Can be medium OR Vacuum
- Emit/Absorb electromagnetic radiation

↳ Working principle: All objects emit and absorb electromagnetic radiation at the same time.

### ★ AFFECTING FACTORS

① Surface temperature ↑  
 Rate of energy transfer ↑

similar to: concentration gradient

#### ② Surface Area

SA ↑  
 Rate of energy transfer ↑

"effective heat dissipation"

#### ③ Surface colour & temperature

Dark - White  
 Matte - Shiny  
 Rough - Smooth

emit/absorb energy faster

Emit/absorb energy slower

faster rate — slower rate

★ Good emitter = Good Absorber  
 Poor emitter = Poor Absorber