GAS LAW PROBLEMS

PVT

1] A gas occupies 473 cm^3 at 36°C. Find its volume at 94°C.

Hint

1	2
C	G
B	A
4	3

$P \times V$ ⇐ Temp

1	2
P	V
T	n
4	3

Gas laws ⇒ P, V, T, n

1) Boyle's law — $PV = nRT$
2) charle's law —
3) Gay-lussac law — Universal Gas constant
4) Avogadro's law, $\boxed{PV \propto nT}$

Boyle's law

Temp = constant

$PV = \text{constant}$

$P \propto \frac{1}{V}$

P V T

GAS LAW PROBLEMS

PVT

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Hint

1	2
O	G
B	A
4	3

P×V

Temp

1	2
P	V
T	n
4	3

Hint

Boyle's law

Temp = constant ✓

PV = constant

Charle's law

P = constant

$\frac{V}{T}$ = constant

$\boxed{V \propto T}$

Gay-L

P V T

GAS LAW PROBLEMS

PVT

1] A gas occupies 473 cm³ at 36°C. Find its volume at 94°C.

1	2
C	G
B	A
4	3

P×V

Temp

1	2
P	V
T	n
4	3

Boyle's law

Temp = constant

PV = constant

$\boxed{P \propto \frac{1}{V}}$

Charle's law

P = constant

$\frac{V}{T}$ = constant

$\boxed{V \propto T}$

Gay-lussac law

V = constant

$\frac{P}{T}$ = constant

$\boxed{P \propto T}$

C | G
B | A

P | V
T | n

P ⇒ Pa, atm, torr

GAS LAW PROBLEMS

2] A gas occupies 100 mL at 150 kPa. Find its volume at 200 kPa.

V_1 P_1 V_2 P_2

Given:

$V_1 = 100.\ \text{mL}$

$P_1 = 150.\ \text{kPa}$

$P_2 = 200.\ \text{kPa}$

Find: $V_2 = ?$

Formula : $\cancel{V_1T_2 = V_2T_1}$ $P_1V_1 = P_2V_2$

Solution: $P_1V_1 = P_2V_2$

We know $\cancel{V_1T_2 = V_2T_1}$

$\therefore (150)(100) = (200)V_2$

$$\mathbf{V_2 = 75.0\ mL}$$

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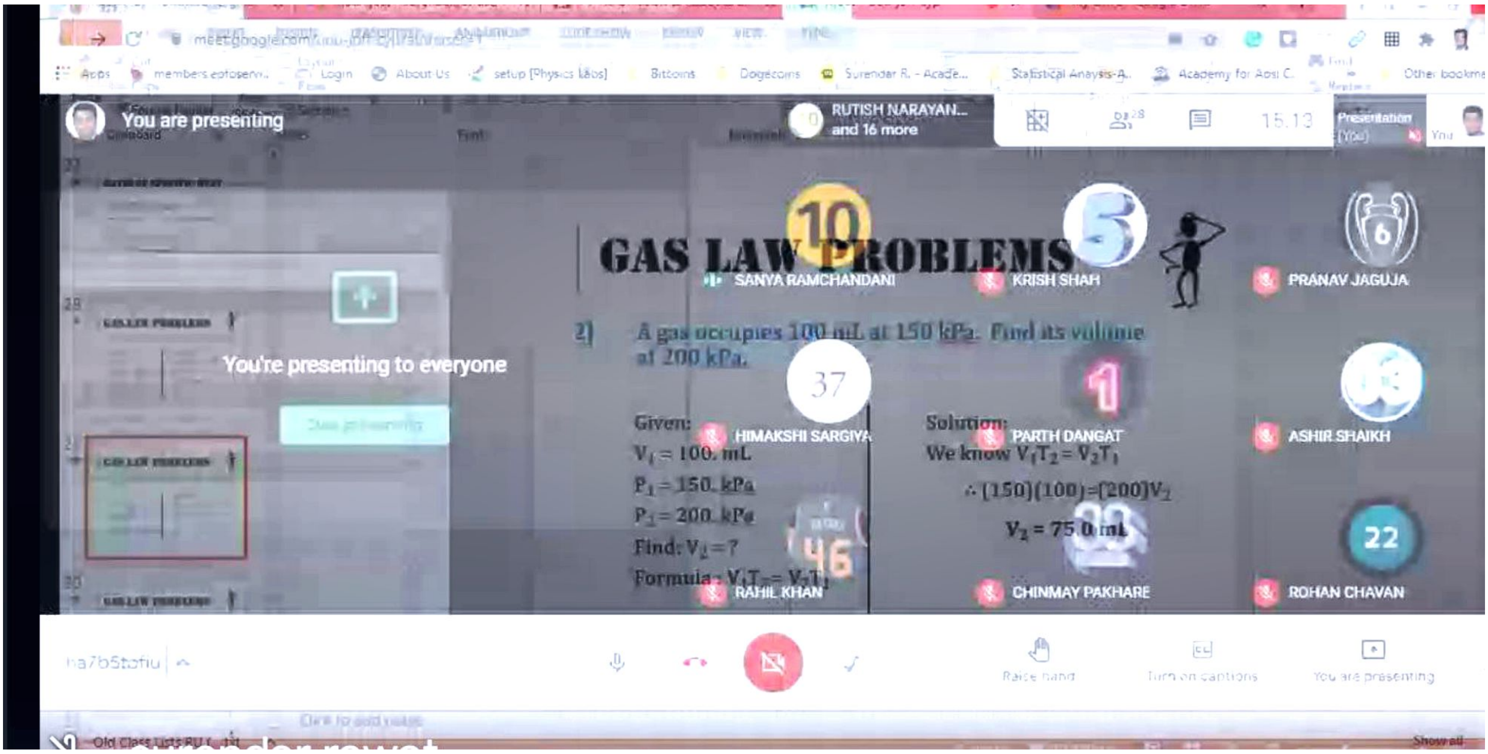

You are presenting
RUTISH NARAYAN... and 16 more
GAS LAW PROBLEMS
2) A gas occupies 100 mL at 150 kPa. Find its volume at 200 kPa.
Given:
Find: V2 = ?
Solution:
V2 = 75.0 mL
You're presenting to everyone
SANYA RAMCHANDANI
KRISH SHAH
PRANAV JAGUJA
HIMAKSHI SARGIYA
PARTH DANGAT
ASHIR SHAIKH
RAHIL KHAN
CHINMAY PAKHARE
ROHAN CHAVAN

OBJECTIVES

Heat & Temp

- To understand the difference between heat and temperature
- To define calorie
- To study absolute zero, units of temperature: °C, °F,°K, with their conversion.

Conduction

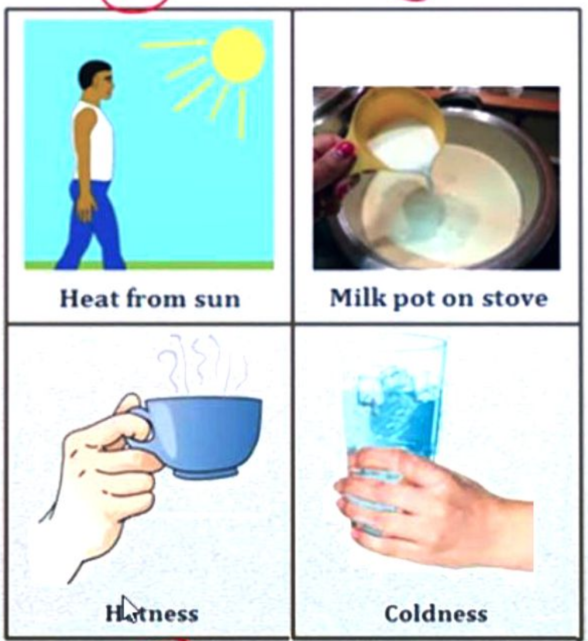
- To know conduction, state law of thermal conductivity and define coefficient of thermal conductivity
- To differentiate good conductors of heat & insulators with suitable examples
- To realize the applications of conduction.
- To study convection and state applications of convection.
- To study radiation and state applications of radiation.

HEAT AND TEMPERATURE

HEAT AND TEMPERATURE

- **Heat** is the form of energy that is transferred from the body which is at high temperature to the body at lower temperature.

- **Temperature** is the measure of degree of hotness or coldness of a body.



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5

- The metric unit for measuring heat is the ***joule***.
- This is the same joule used to measure all forms of energy, not just heat.
- **1 calorie:** It is the amount of heat required to raise the temperature of 1 gram of water by 1°C.
- **1 kilocalorie:** It is the amount of heat required to raise the temperature of 1 kilogram of water by 1°C.

Unit	Is Equal To
1 calorie	4.186 joules
1 kilocalorie	1,000 calories

UNIT OF HEAT

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Q   m   T/θ   Q   m   T/θ

Q = heat
m = mass
θ = Temp

Unit	Is Equal To
1 calorie	4.186 joules
1 kilocalorie	1,000 calories

$Q \propto m\theta$

$Q = cm\theta$

sp. heat

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c = sp heat

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Q T/θ m

1 kcal = 4186 J

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m = mass
θ = temp
c = sp heat

Unit	Is Equal To
1 calorie	4.186 joules
1 kilocalorie	1,000 calories

$Q \propto m\theta$

$$\boxed{Q = cm\theta}$$

sp. heat

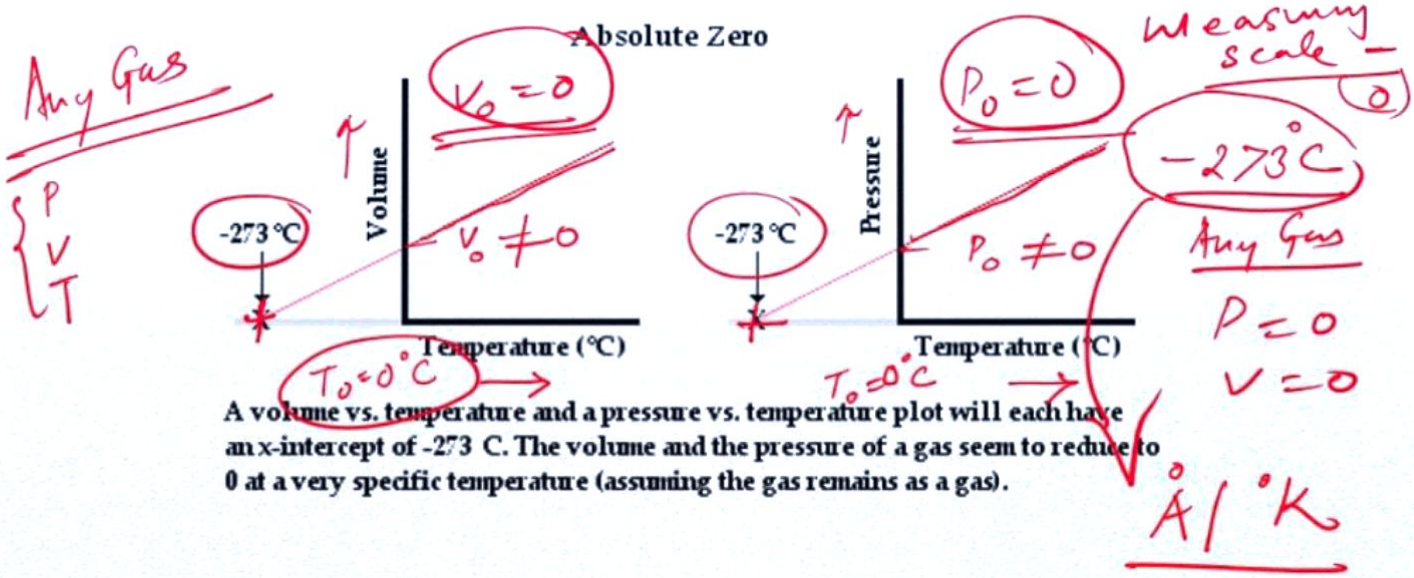
UNIT OF HEAT

10 A
1A ⇒ 1J
10A ⇒ 10J

Heat	Temperature
1. Energy that is transferred from the body at higher temperature to the body at lower temperature.	1. Measure of degree of hotness or coldness of the body.
2. It is measurement of number of atoms multiplied by energy possessed by each atom.	2. It determines the direction in which 'heat' will flow.
3. It has ability to do work.	3. It is only used to measure the degree of heat.
4. Symbol of heat is Q	4. Symbol of temperature is T
5. SI unit is Joule	5. SI unit is Kelvin

COMPARISON

NEW TEMPERATURE SCALE

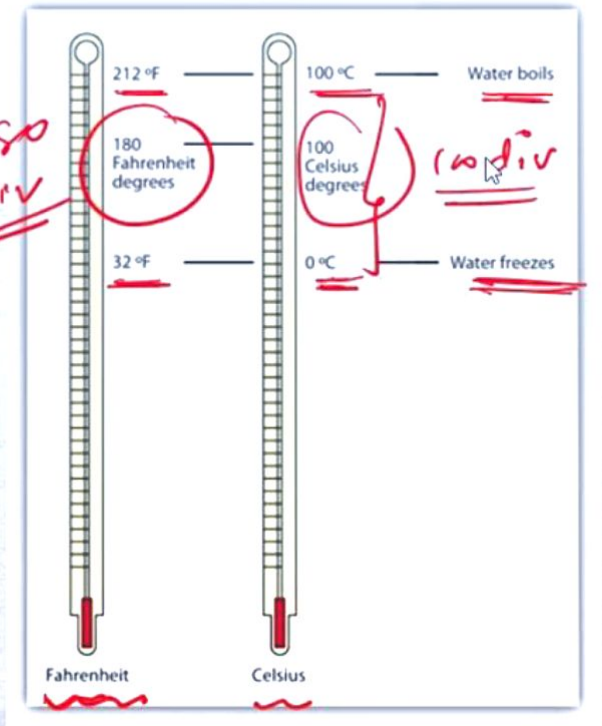


A volume vs. temperature and a pressure vs. temperature plot will each have an x-intercept of -273 C. The volume and the pressure of a gas seem to reduce to 0 at a very specific temperature (assuming the gas remains as a gas).

TEMPERATURE SCALE

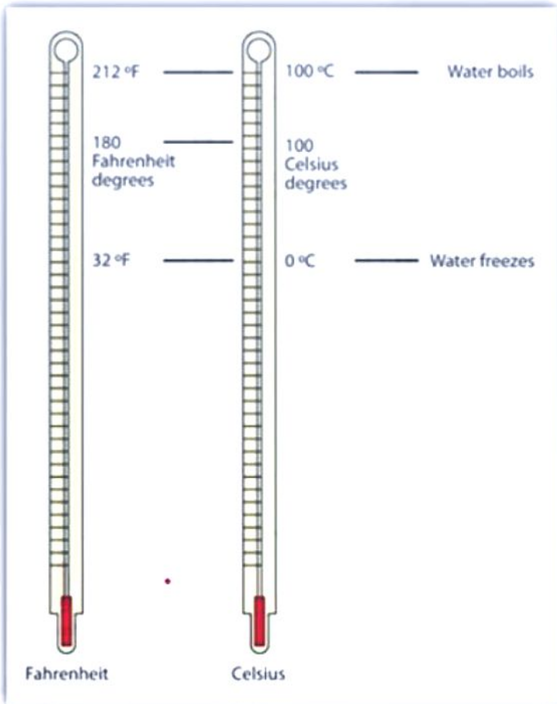
$$\begin{array}{r} 212 \\ -\ 32 \\ \hline 180 \end{array}$$

180 div

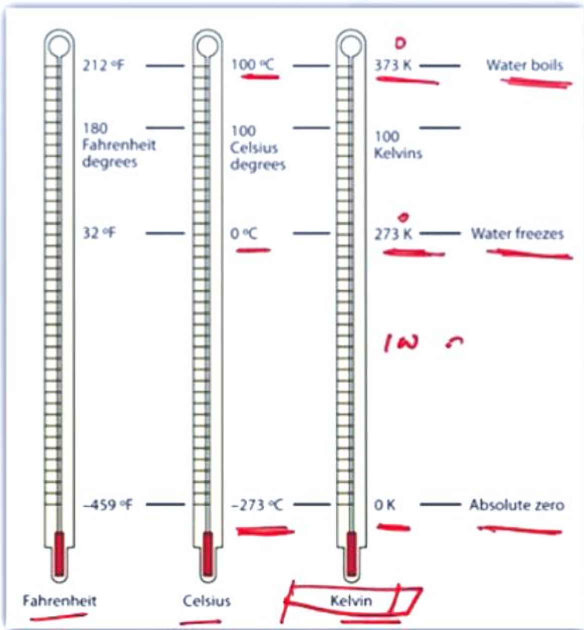


TEMPERATURE SCALE

- In the **Fahrenheit scale**, water freezes at 32° and boils at 212° and in **Celsius scale**, water freezes at 0° and boils at 100°.
- The **Celsius scale** divides the difference between the freezing and boiling points of water into 100° whereas the **Fahrenheit scale**, divides into 180°.



TEMPERATURE SCALE



CONVERSION OF TEMPERATURE

- To convert temperature from one scale to another, simple relationships between temperatures in different scales are given below

$102^\circ F$

- The conversion between Celsius and Fahrenheit scales is as follows:

1. $$^\circ C = (^\circ F - 32) \times \frac{5}{9} = (102-32) \times \frac{5}{9} = \frac{70 \times 5}{9}$$

$$^\circ F = \left(\frac{9}{5} \times {}^\circ C\right) + 32 \qquad = \frac{350}{9} = 38.89$$

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$36^{\circ}C - 37^{\circ}C$

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CONVERSION OF TEMPERATURE

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102°F

(1) $$°C = (°F - 32) \times \frac{5}{9}$$ $= (102-32) \times \frac{5}{9} = \frac{70 \times 5}{9}$

$= \frac{350}{9} = 38.89°$

$36°C - 37°C$

35°C

(2) $$°F = \left(\frac{9}{5} \times °C\right) + 32$$

$= \left(\frac{9}{5} \times 35\right) + 32$

$= 63 + 32$

$= 95°F$

CONVERSION OF TEMPERATURE

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- The conversion between Celsius and Fahrenheit scales is as follows:

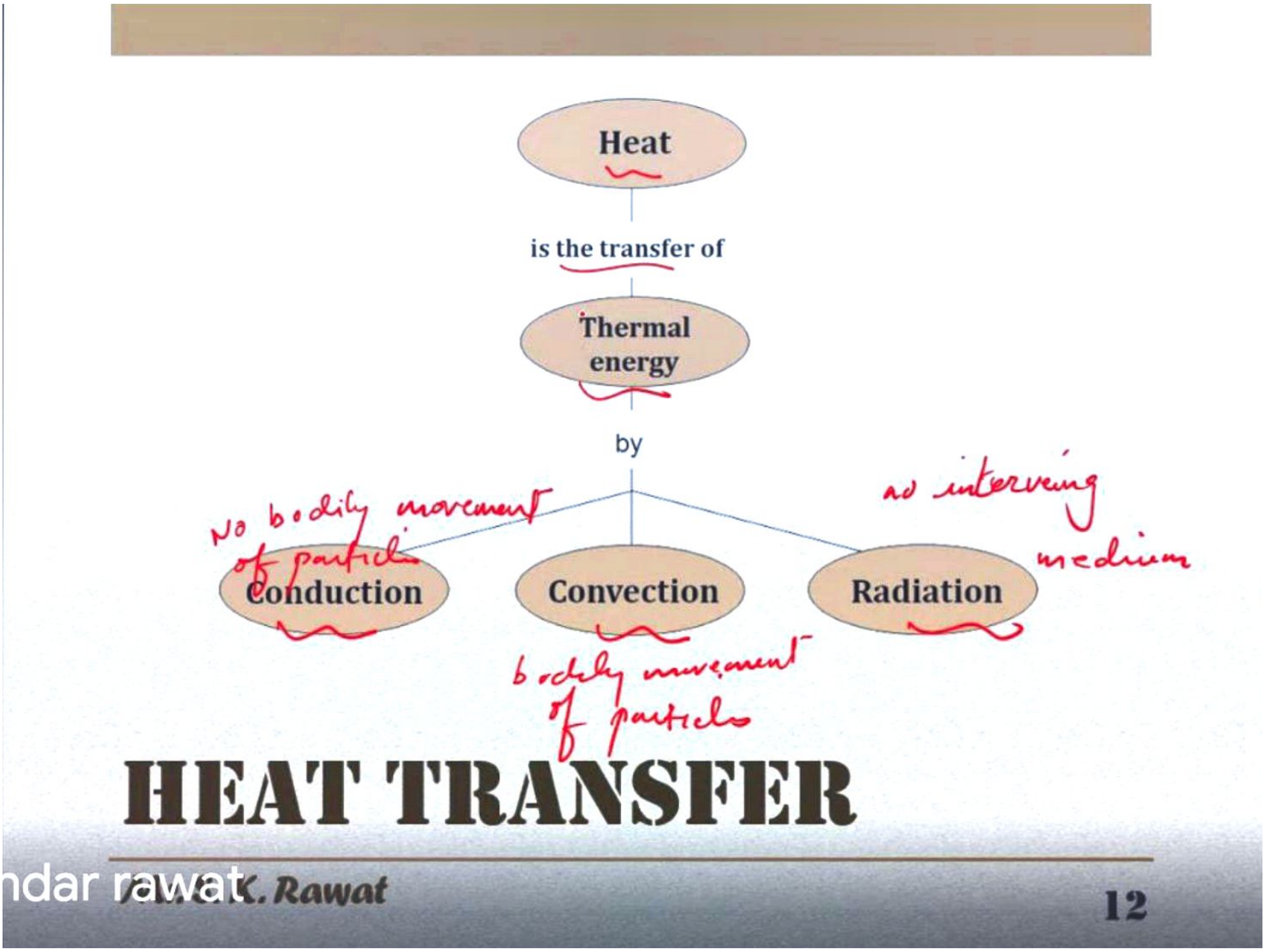
$$°C = (°F - 32) \times \frac{5}{9}$$

$$°F = \left(\frac{9}{5} \times °C\right) + 32$$

- The conversion between the Kelvin and Celsius scales is as follows:

$$°K = °C + 273$$

$$°C = °K - 273$$


Heat
is the transfer of
Thermal energy
by
No bodily movement of particles
Conduction
Convection
bodily movement of particles
Radiation
no intervening medium
HEAT TRANSFER
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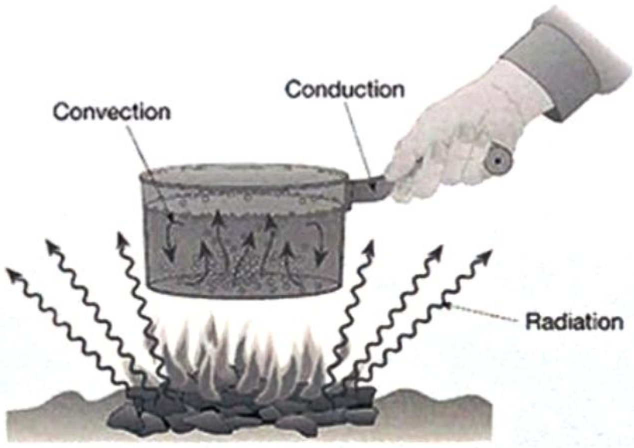
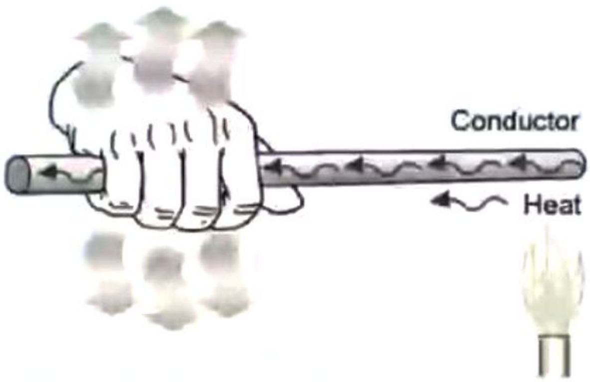
- Thermal energy flows from higher temperature to lower temperature. This process is called heat transfer.
- There are three distinct modes of heat transfer:
  - ***conduction***,
  - ***convection***, and
  - ***radiation***.



HEAT TRANSFER

- **Conduction** is a process of transfer of heat from a part of body at higher temperature to a part of body at lower temperature without bodily (actual) movement of particles.
- It takes place through solids.



CONDUCTION

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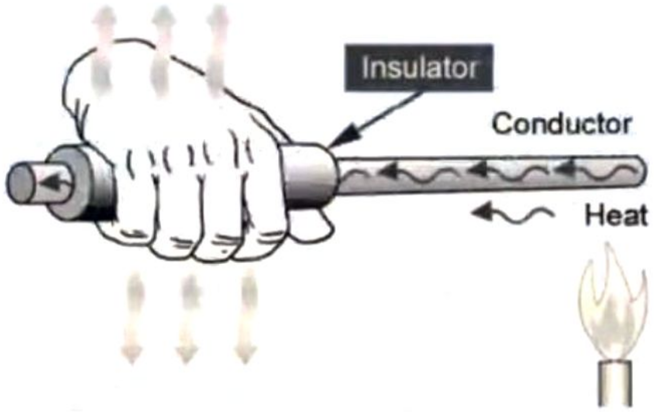
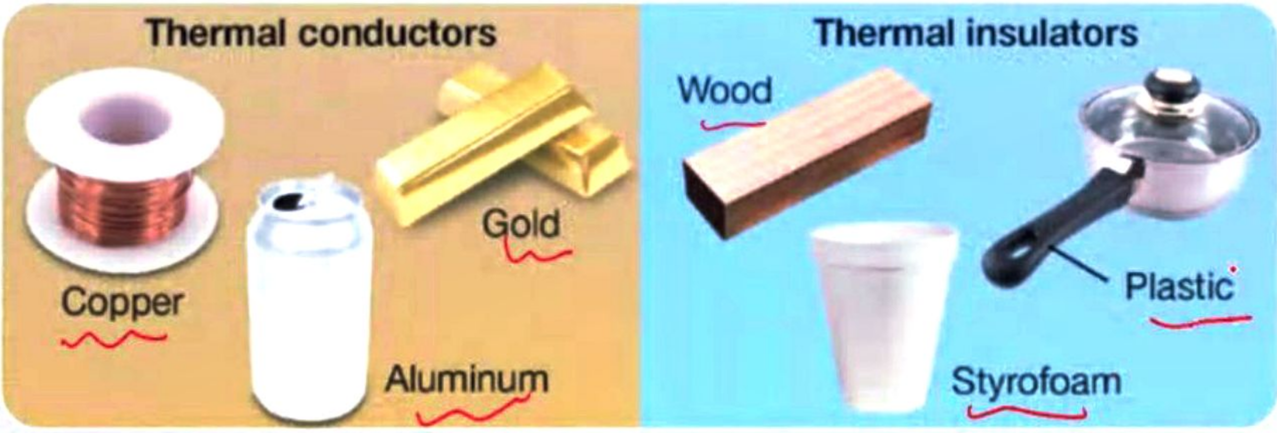
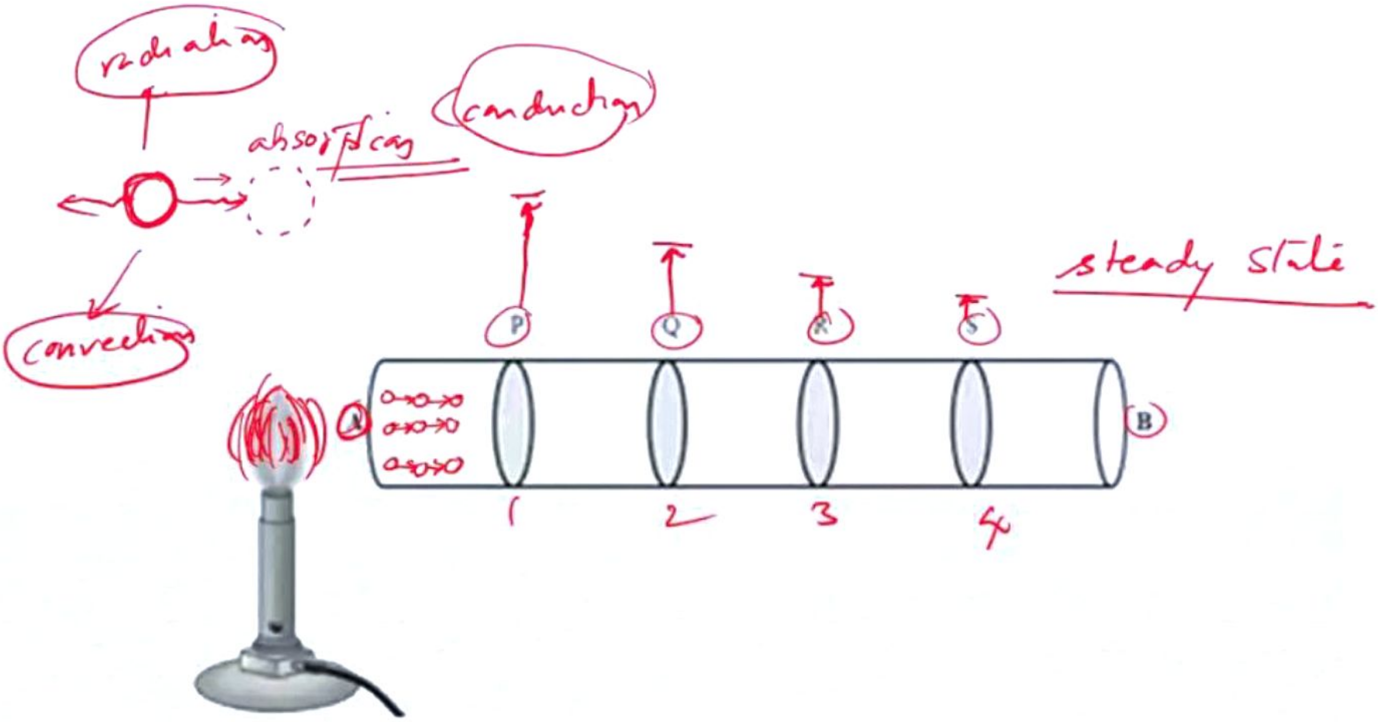
- Most metals are good conductors i.e they easily transmit heat energy by conduction.
- Bad conductors are called **insulators** i.e they do not easily transmit heat by conduction e.g. wool, wood, plastic, most liquids and gases.



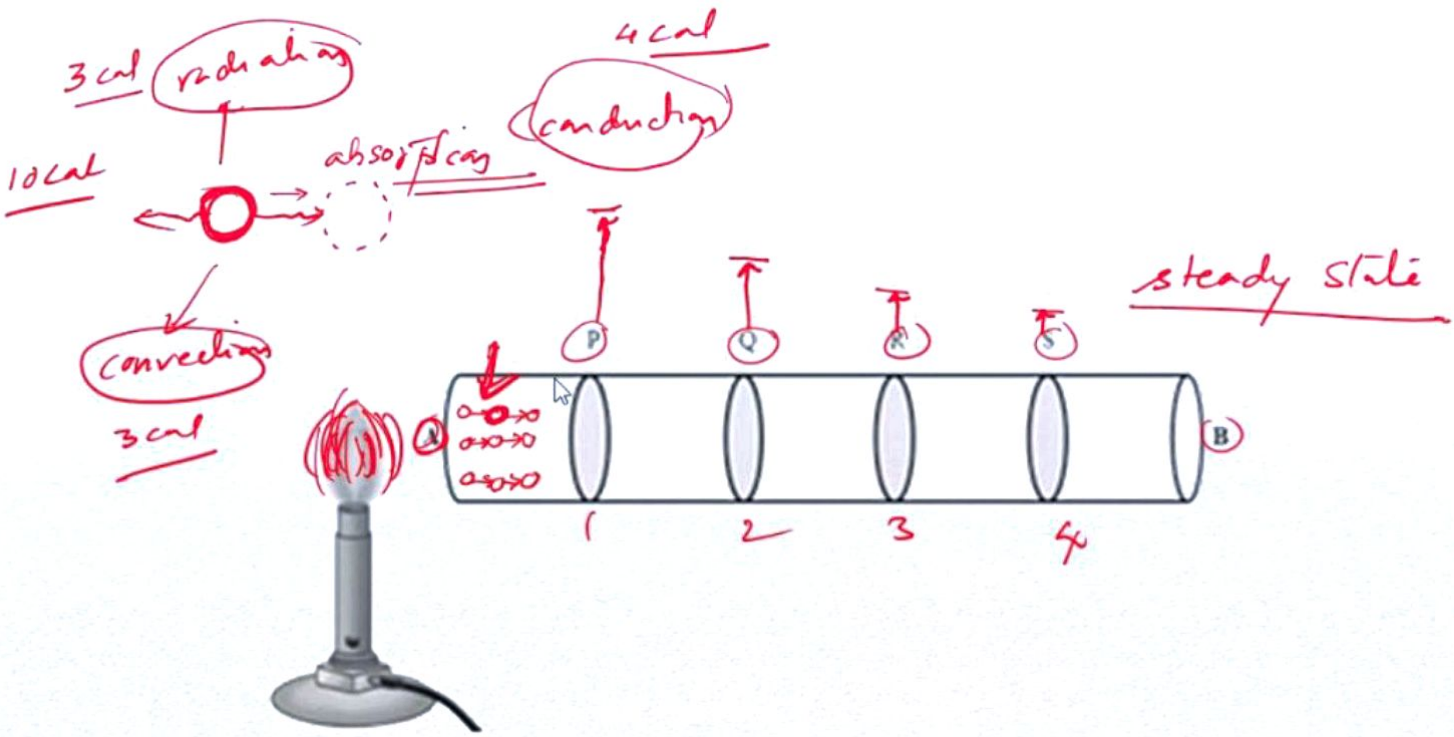
CONDUCTORS & INSULATORS

Thermal Conductors and Insulators





HEAT CONDUCTION



HEAT CONDUCTION

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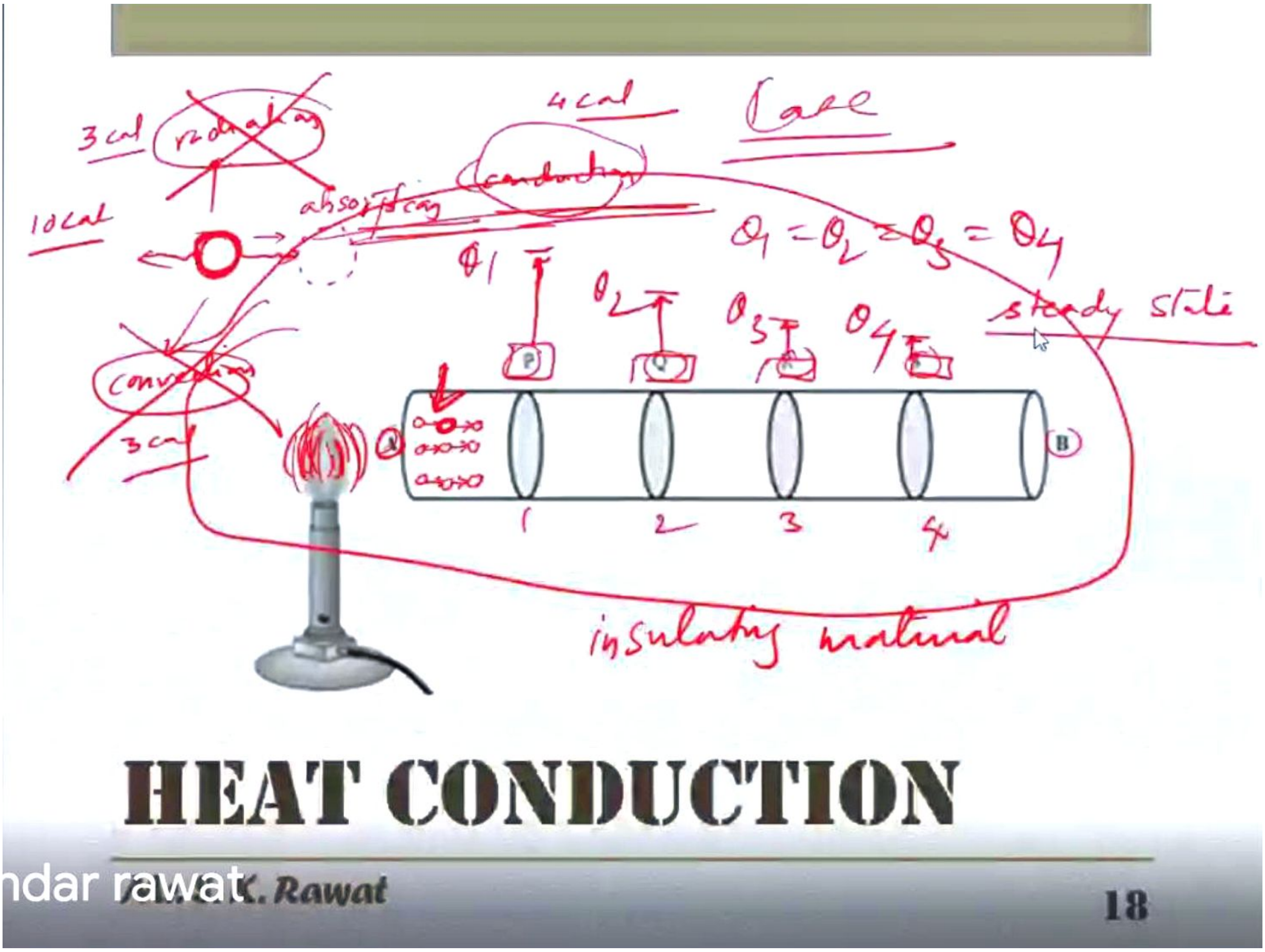
3 cal
4 cal
10 cal
conduction
$\theta_1 = \theta_2 = \theta_3 = \theta_4$
steady state
θ_1
θ_2
θ_3
θ_4
P
Q
A
B
1
2
3
4
3 cal
insulating material
HEAT CONDUCTION
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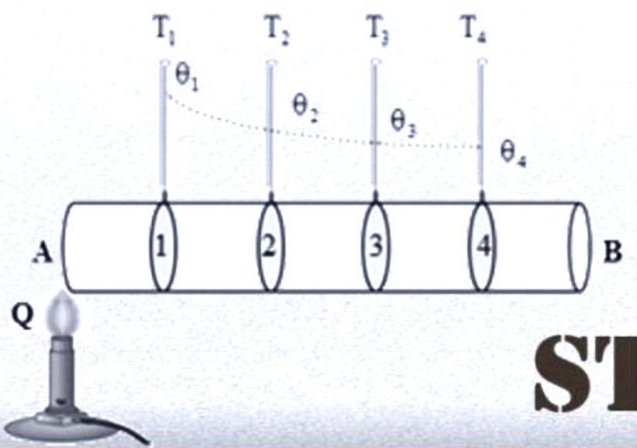
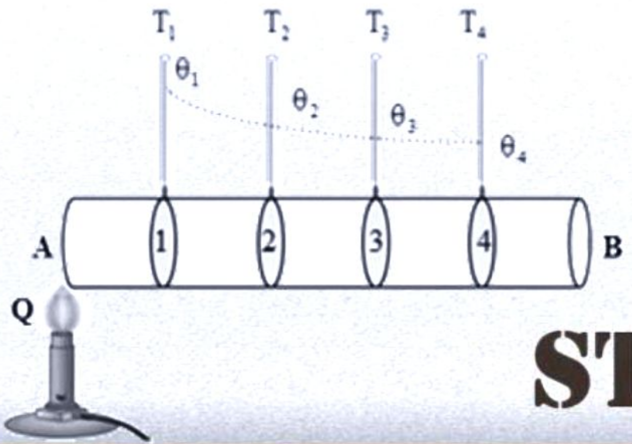
- Therefore its temperature also increase but will be less than.
- As time for which heat provided increase, temperature, shown by all thermometers goes on increasing.
- This state is called variable state.



Variable state is the period during which temperature shown by all thermometers goes on increasing.

STEADY STATE

- After some time a stage is reached as shown.
- Temperature in all the thermometers remains constant i.e. temperature will not increase further, this state is called **steady state**.
- In this steady state, heat absorbed by material is equal to heat given out.
- Thus in this state whatever heat is gained is given to the surrounding & to next element without any absorption.



STEADY STATE

THERMAL CONDUCTIVITY

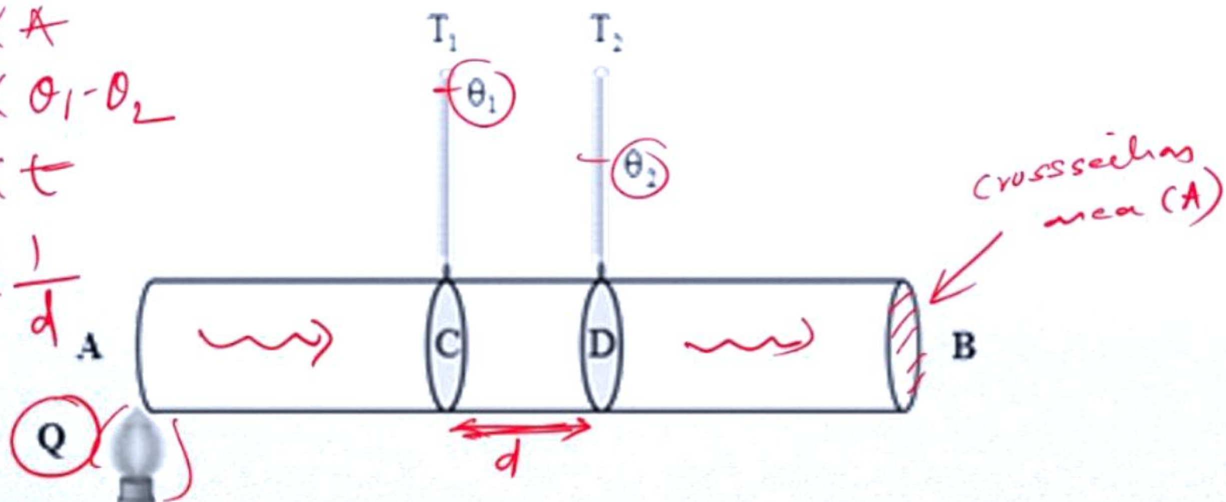
Practically:

$Q \propto A$

$Q \propto \theta_1 - \theta_2$

$Q \propto t$

$Q \propto \frac{1}{d}$



't' sec

THERMAL CONDUCTIVITY

Practically

$Q \propto A$

$Q \propto \theta_1 - \theta_2$

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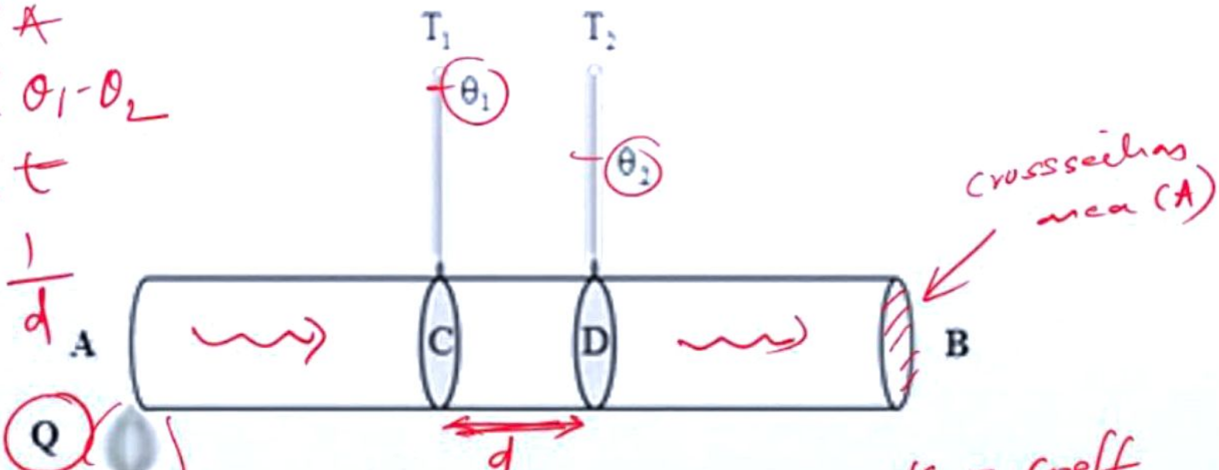


t sec

$$Q \propto \frac{A(\theta_1-\theta_2)t}{d}$$

K = coeff of thermal conductivity

$$Q = K\frac{A(\theta_1-\theta_2)t}{d}$$

THERMAL CONDUCTIVITY

- Thus, $Q \propto \frac{A \times (\theta_1 - \theta_2) \times t}{d}$

$$\therefore \qquad Q = K \times A \times \frac{(\theta_1 - \theta_2)}{d} \times t$$

Here K = constant of proportionality and called as coefficient of thermal conductivity.

- The value of K depends on material of a metal rod.
- The above equation determines the amount of heat flowing or absorbed by the body.
- The factor $\frac{(\theta_1 - \theta_2)}{d}$ is called temperature gradient.

TEMPERATURE GRADIENT

- As we know, the amount of heat flowing or absorbed by the body is given as

$$\boxed{Q = K \times A \times \frac{(\theta_1 - \theta_2)}{d} \times t} \Rightarrow$$

- Writing the above equation in terms of coefficient of thermal conductivity, we get

$$\therefore \quad \boxed{K = \frac{Q \times d}{A \times (\theta_1 - \theta_2) \times t}} \Leftrightarrow$$

$$\boxed{K = Q}$$

when

$d = 1$
$A = 1$
$\theta_1 - \theta_2 = 1$
$t = 1$

conditions

COEFFICIENT OF THERMAL CONDUCTIVITY

- We know $$K = \frac{Q \times d}{A \times (\theta_1 - \theta_2) \times t} = \frac{cal \times m}{m^2 \times {}^\circ C \times sec}$$

- CGS unit of K $$= \frac{cal}{m\,{}^\circ C\, sec}$$

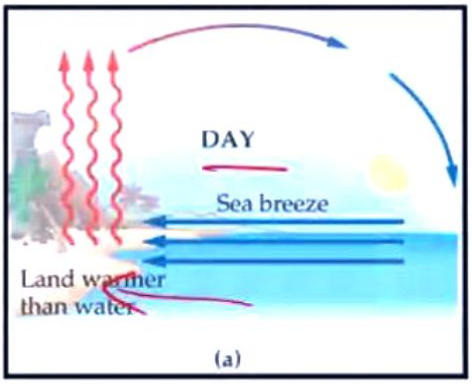
- MKS unit of K $$= \frac{kcal}{m\,{}^\circ C\, sec}$$ MKS $$= \frac{watt}{m\,{}^\circ K}$$ SI

$$\frac{kcal}{sec} \Rightarrow watt$$

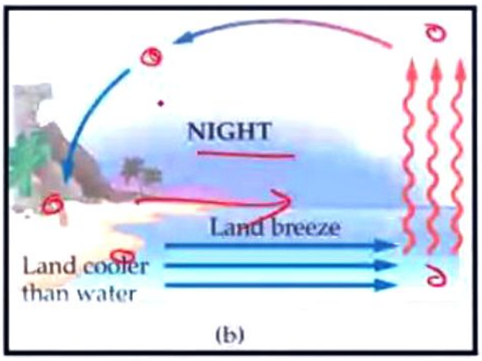
$${}^\circ C \Rightarrow {}^\circ K$$

UNIT OF K

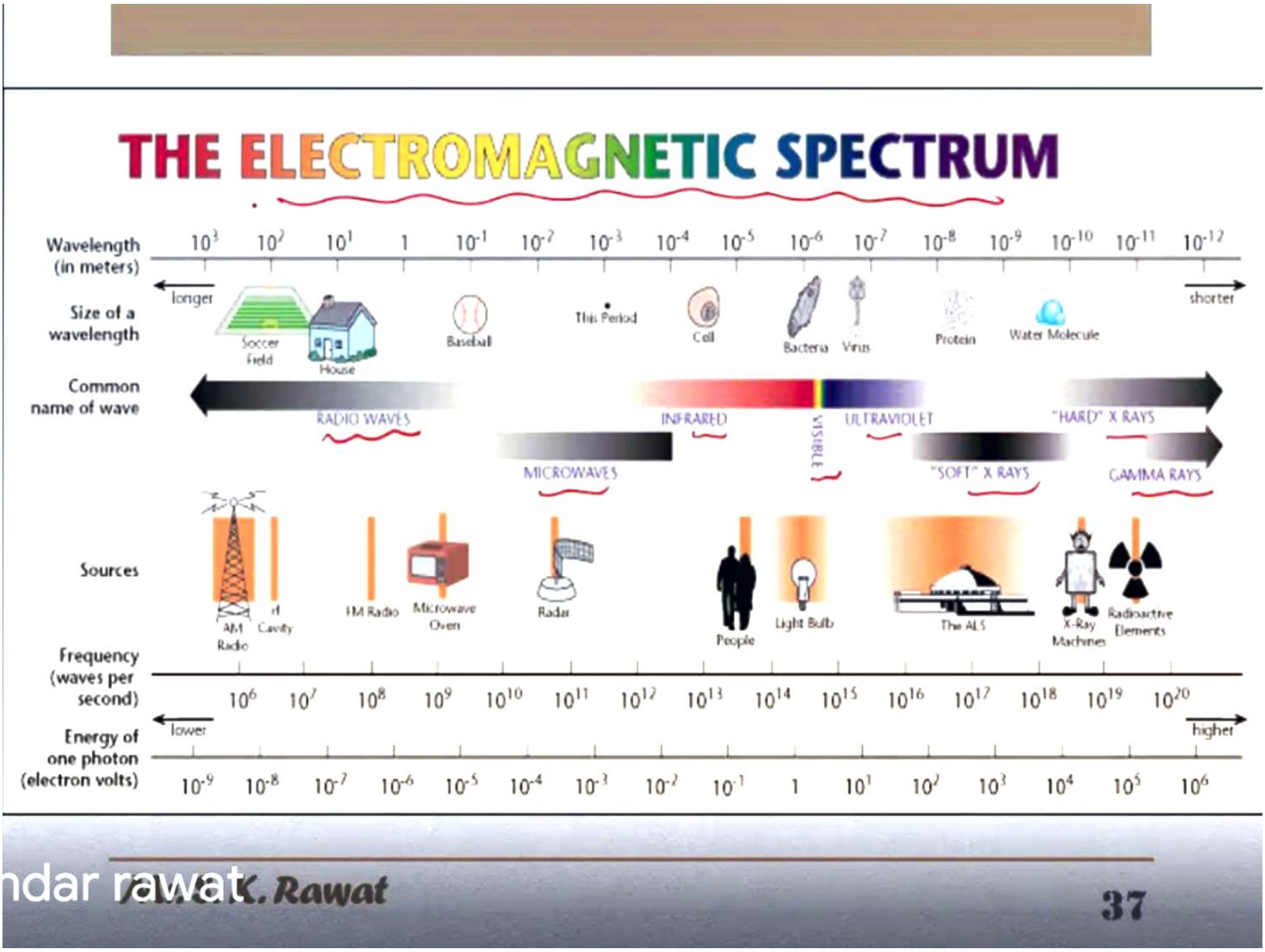
- On a smaller scale near coastlines, convection is responsible for sea breezes.
- During the daytime, land is much hotter than the ocean.



- A sea breeze is created when hot air over the land rises due to convection and is replaced by cooler air from the ocean.
- At night the temperature reverses so a land breeze occurs.



CONVECTION & SEA BREEZE


THE ELECTROMAGNETIC SPECTRUM
Wavelength (in meters)
10^{3} 10^{2} 10^{1} 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}
longer
shorter
Size of a wavelength
Soccer Field
House
Baseball
This Period
Cell
Bacteria
Virus
Protein
Water Molecule
Common name of wave
RADIO WAVES
INFRARED
VISIBLE
ULTRAVIOLET
"HARD" X RAYS
MICROWAVES
"SOFT" X RAYS
GAMMA RAYS
Sources
AM Radio
rf Cavity
FM Radio
Microwave Oven
Radar
People
Light Bulb
The ALS
X-Ray Machines
Radioactive Elements
Frequency (waves per second)
10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20}
lower
higher
Energy of one photon (electron volts)
10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6}
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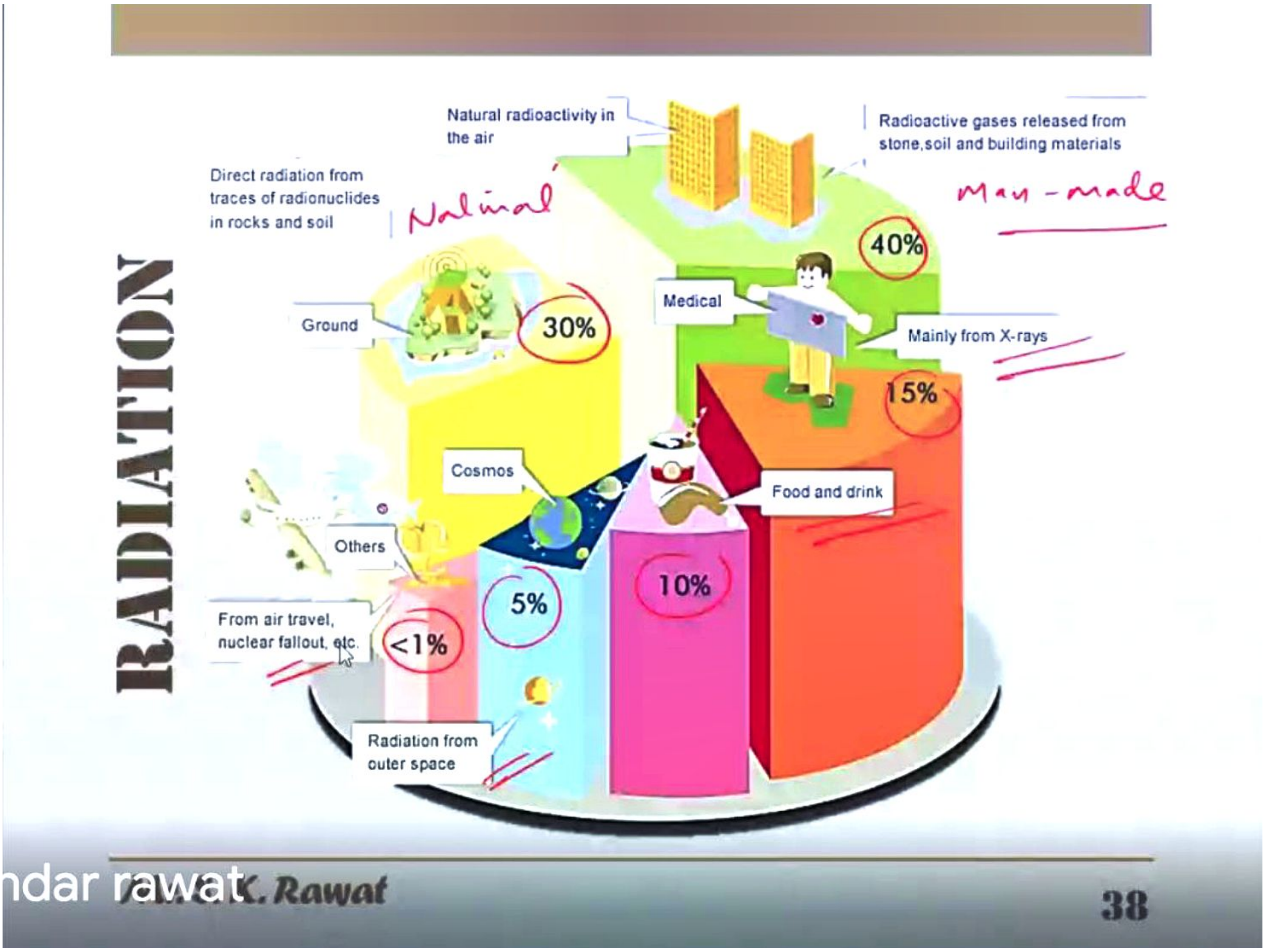
RADIATION
Natural radioactivity in the air
Radioactive gases released from stone,soil and building materials
Direct radiation from traces of radionuclides in rocks and soil
Natural
Man-made
40%
Medical
Ground
30%
Mainly from X-rays
15%
Cosmos
Food and drink
Others
10%
5%
From air travel, nuclear fallout, etc.
<1%
Radiation from outer space
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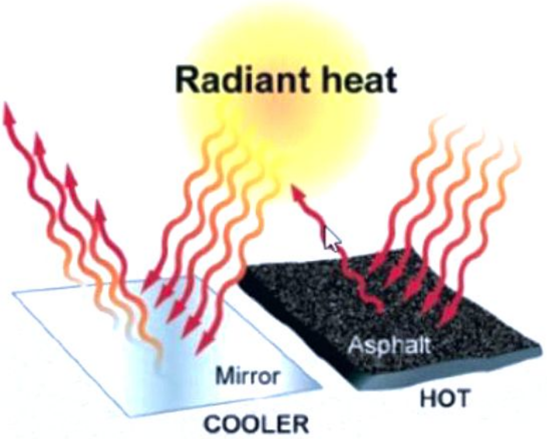
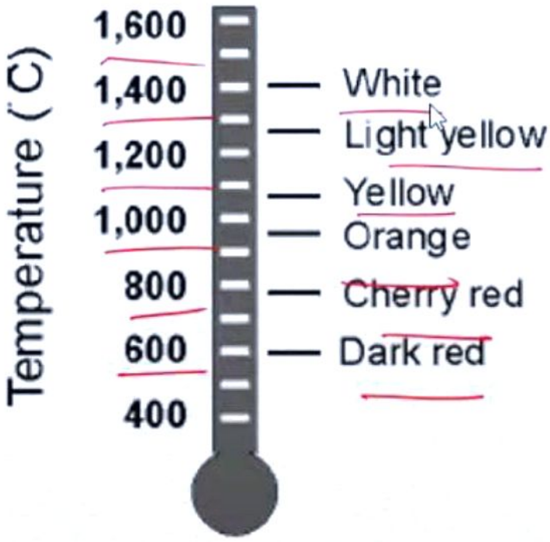


- Thermal radiation is also *absorbed* by objects.
- The amount of thermal radiation absorbed depends on the surface of a material.
- Dark surfaces absorb most of the thermal radiation they receive.

- Silver or mirrored surfaces reflect thermal radiation.

THERMAL RADIATION

- We do not see the thermal radiation because it occurs at **infrared wavelengths** invisible to the human eye.
- Objects glow different colors at different temperatures.



RADIANT HEAT

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- Bug zappers attract insects using ultraviolet radiation. The light fixture is surrounded by a mesh cage, which is energized with a low voltage current.
- Insects drawn to the UV radiation attempt to pass through the electrified mesh, and are subsequently electrocuted.

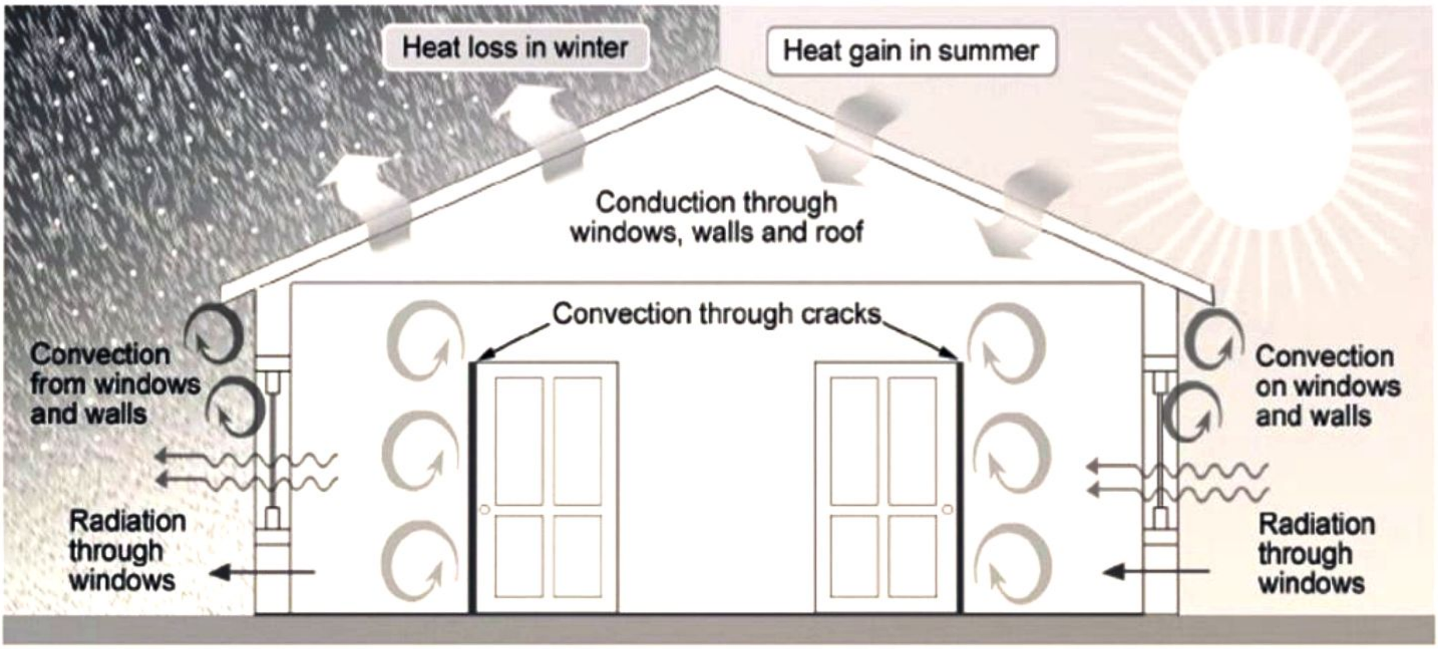
Bug zappers

- Ultraviolet radiation itself is invisible to the human eye, but illuminating certain materials with UV radiation prompts the visible effects of fluorescence and phosphorescence.
- Black light testing is commonly used to authenticate antiques and banknotes."

RADIATION

APPLICATION:

Asia | Gulf | Africa



ENERGY-EFFICIENT HOUSE

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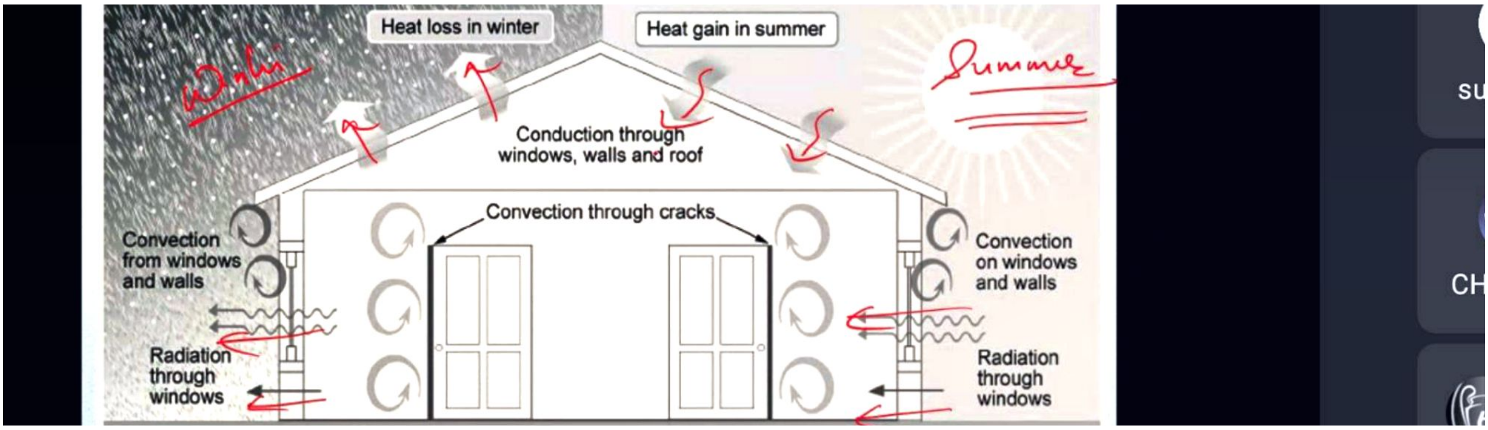
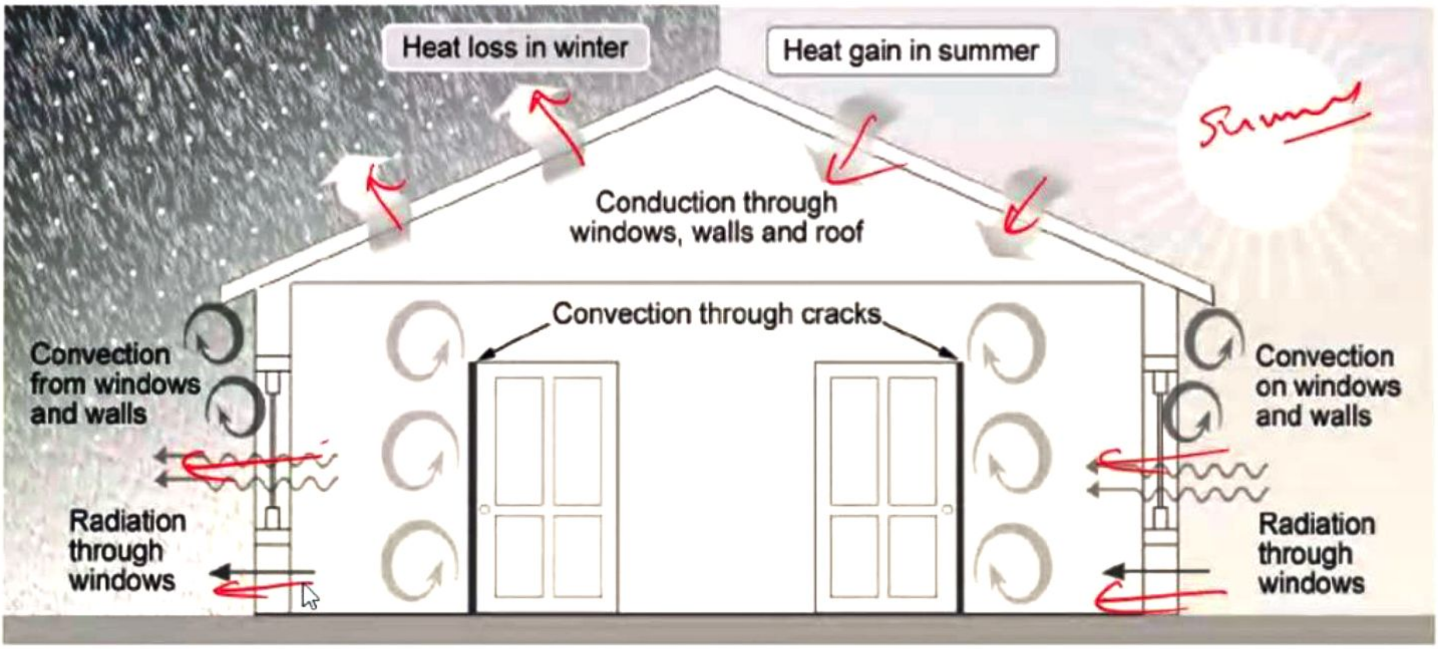

Heat loss in winter
Heat gain in summer
Conduction through windows, walls and roof
Convection through cracks
Convection from windows and walls
Radiation through windows
Convection on windows and walls
Radiation through windows

APPLICATION:



ENERGY-EFFICIENT HOUSE

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