

# Heat & Temperature.

classmate

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**Heat** :- Heat is the form of energy which stimulates our sense organ, so that we feel hot or cold.

The direction of heat energy transfer always takes place from warmer body to colder body.

- Heat is caused by the change in internal energy of matter. Internal energy  $\rightarrow$  sum of.

- (i) Molecular kinetic energy :- Due to random motion of molecules
- (ii) Molecular potential energy :- Due to intermolecular force that acts between molecules.
- (iii) Other types of molecular energy.

# Unit of Joule :- Joule in S.I units & Calories in CGS units

# Temperature :- It is degree of hotness or coldness of body. If two systems are in thermal equilibrium, they are at same temperature.

=> Difference Between Heat & temperature.

Heat	Temperature.
(i) Heat is the form of energy	Temperature is the degree of hotness or coldness.
(ii) Units :- Joule - SI, Calories - CGS.	Units :- Kelvin - SI, Celsius (C) - CGS.
(iii) It is cause	It is effects.
(iv) It is measure of total kinetic E of all molecules	It is measure of average kinetic E of all molecules.
(v) Two bodies can be in thermal equilibrium without having same amount of heat.	Two bodies cannot be in thermal equilibrium if they are at different temperature.

#  $-273^{\circ}\text{C}$  is Absolute 0,



## # Thermometry:

- Science of temperature & its measurement.
- The instrument used to measure the temperature is called thermometer.

⇒ Mercury Thermometer:- Mercury is used as the thermometric substance. One end of thermometer is sealed with mercury inside the wide bulb & it is connected with very narrow hair-like capillary tube.

- The principle is that when the heat is given to mercury it expands through the capillary tube. & when heat is released it gets contracted.

### - Advantage

- Its boiling point is  $375^{\circ}\text{C}$  & its freezing point is  $-39^{\circ}\text{C}$ . So, it can measure a wide range of temperature.
- It doesn't wet the surface of glass.
- Its expansion rate is uniform.
- Its specific heat is very less, so that it needs less energy.

### - Disadvantage

- It can't be used below temp  $-39^{\circ}\text{C}$  & above  $375^{\circ}\text{C}$ . So, it can be used at a very cold region.

⇒ Alcohol Thermometer.

- Construction is same as a mercury thermometer.
- Alcohol is used as the thermometric substance.

### - Advantage

- Its boiling pt.  $78^{\circ}\text{C}$  & freezing point  $-110^{\circ}\text{C}$ . So, it is suitable in cold place.
- Its sensitivity is very high i.e. 7 times more sensitive than mercury.



- Disadvantage

- (i) It sticks the surfaces of glass.
- (ii) Its expansion rate isn't uniform
- (iii) It is transparent
- (iv) Its specific gravity is lesser than that of mercury.

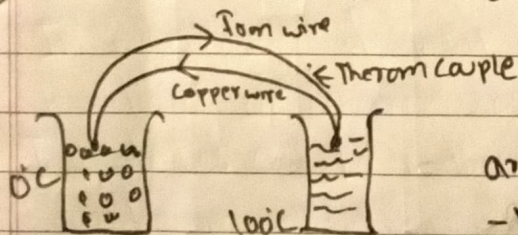
## # Types of thermometer.

① Liquid thermometer:- Liquid thermometer based on the principle of change in  $\text{Vol}^m$  with change in temperature.  
eg:- mercury & Alcohol thermometer.

② Gas thermometer:- based on the principle of change in pressure & volume with change in thermometer.  
eg - Callender's constant pressure thermometer Constant Volume hydrogen thermometer.  
- Range :-  $-200^\circ\text{C}$  to  $1600^\circ\text{C}$ .

③ Resistance Thermometer:- It is based on the principle of change in resistance with change in temperature  
Range :  $-270^\circ\text{C}$  to more than  $700^\circ\text{C}$  ex:- platinum thermo

④ Thermoelectric Thermometer:- Based on principle of thermoelectricity, i.e. production of thermo emf in a thermocouple, when two junctions are at different temp.  
- Range:  $-270^\circ\text{C}$  to  $2300^\circ\text{C}$ ,



⑤ Radiation Thermometer:- Based on quantity of radiation emitted by a body. These are also called pyrometers.  
These thermometer measure very high temp.

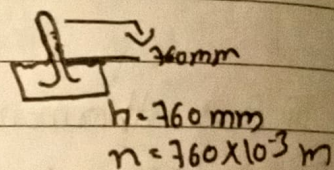


- ② Vapour <sup>thermometer</sup> pressure
- based on the principle of change in vapour pressure with change in temp<sup>r</sup>
  - Eg:- Helium Vapour pressure thermometer (measure very low temp) Range 0.11K to 120K

### # Temperature Scale:

- On the basis of two fixed pts, temp<sup>r</sup> scale are prepared
  - ① lower Fixed Point:- melting point of ice
  - ② upper Fixed point (UFP):- boiling point of water
- { At NTP }

$$\begin{aligned}
 P &= h \rho g \\
 &= 760 \times 10^{-3} \times 13600 \times 9.8 \\
 &= 1.01 \times 10^5 \text{ pa.}
 \end{aligned}$$



### ① Celsius (Centigrade) Scale.

- LFP = 0°C & UFP = 100°C
- These two points are divided into 100 equal division
- 1 Smallest div = 1°C,

### ② Fahrenheit scale

- LFP = 32°F & UFP = 212°F
- These two points are divided in 180 division
- 1 Smallest div = 1°F

### ③ Reaumer scale:

- LFP = 0°R & UFP = 80°R
- These points are divided in 80 division
- 1 Smallest div = 1°R



#### iv Kelvin scale : (Absolute temperature)

- LFP = 273K & UFP = 373K
- These two points are divided in 100 division
- 1 smallest division is = 1K

#### # Conversion of Temperature Scale

Let, C, F, R & K be the temperature reading in Celsius, Fahrenheit, Reaumur & Kelvin respectively

Here,

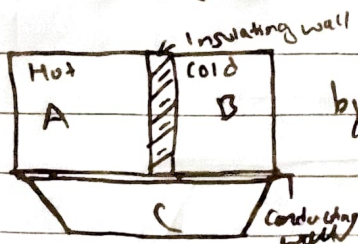
$$\frac{\text{Temp}^{\circ} \text{ reading} - \text{L.F.P.}}{\text{UFP} - \text{L.F.P.}} = \text{Constant}$$

$$\text{i.e. } \frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{R-0}{80-0} = \frac{K-273}{373-273}$$

→ The lowest possible temp<sup>o</sup> of the matter in universe at which the K.E of the molecules of the matter is exactly equal to zero is called absolute zero temp<sup>o</sup>. At this temperature molecules of a body are completely at rest temp<sup>o</sup> in Celsius is -273.15°C which OK.

# Thermal equilibrium :- when hot substances is placed in contact with cold substances, heat flows from hot body to cold body & after some time, the heat flow ceases & both attains common temp<sup>o</sup>. Then, the bodies are said to be in thermal equilibrium.

#### # Zeroth law of thermodynamics



If a system A & system B are separated by the insulating wall. No heat will transfer from A to B.

Again, let another system C which is connected to both A & B with a conducting wall. Now, A will be in thermal equilibrium with B, then, if the insulating wall is removed



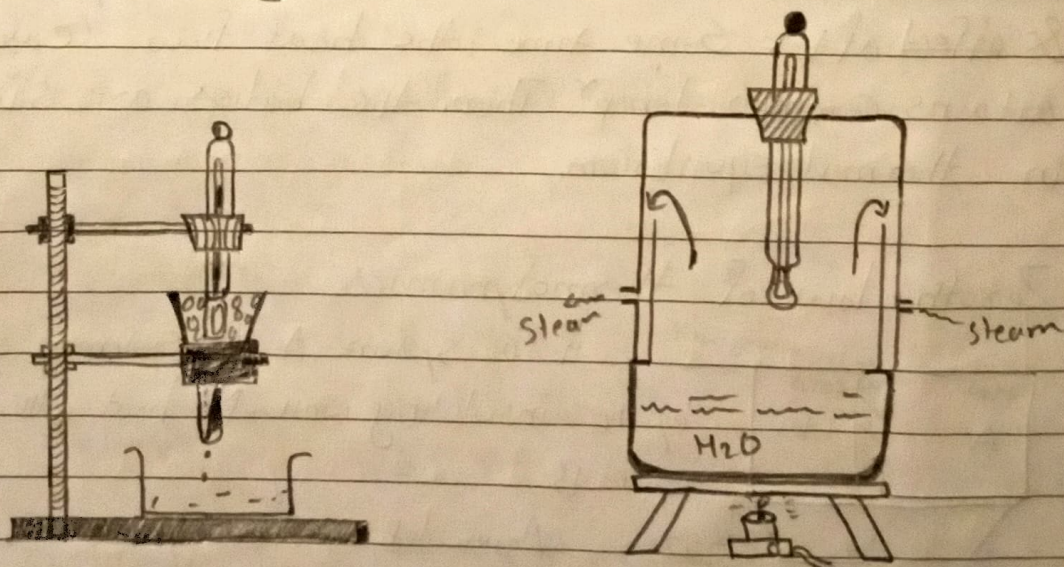
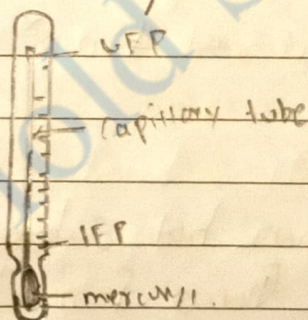
then, it is found that no further change in temp<sup>r</sup> occurs bet<sup>n</sup> System A & B.

That means A & B are also in thermal equilibrium

"If ~~the~~ two system are in thermal equilibrium with third system, then that two system, must be in thermal equilibrium. This is called Zeroth law of thermodynamics.

## # Construction & Calibration of mercury thermometer.

Construction:- The fine capillary tube of glass wide cylinder bulb is taken. Initially it is filled with mercury. It is now put in hot bath. So, that mercury expands & it push away the air out of the capillary until air particles escapes out. After that the upper end is sealed & thermometer is now cooled down. Now, it contain mercury & Vacuum only.





For calibrating the mercury thermometer. two fixed points are determined & marked.

(i) Lower fixed point:- marked as melting point of ice by placing thermometer in ice.

(ii) Upper fixed point:- marked as boiling point of water by placing the thermometer in hypsometer, where water is boiled. As per requirement, the interval bet<sup>n</sup> L.F.P & U.F.P is equally divided according to the temperature scale.

For suppose, In centigrade scale L.F.P is taken  $0^{\circ}\text{C}$  & U.F.P is taken  $100^{\circ}\text{C}$  the interval bet<sup>n</sup> them 100 equal division. Each or division represents one degree.

Q. At what point the thermometric scale does kelvin scale Reading coincide with Fahrenheit scale reading?

Sol<sup>n</sup> //

$$\text{where } K = F - n(116)$$

$$\frac{K - 273}{100} = \frac{F - 32}{180}$$

$$9(x - 273) = x - 32$$

$$\text{or } 9x - 2457 = x - 160$$

$$\text{or } 4x = 2297$$

$$\therefore x = 574.25$$