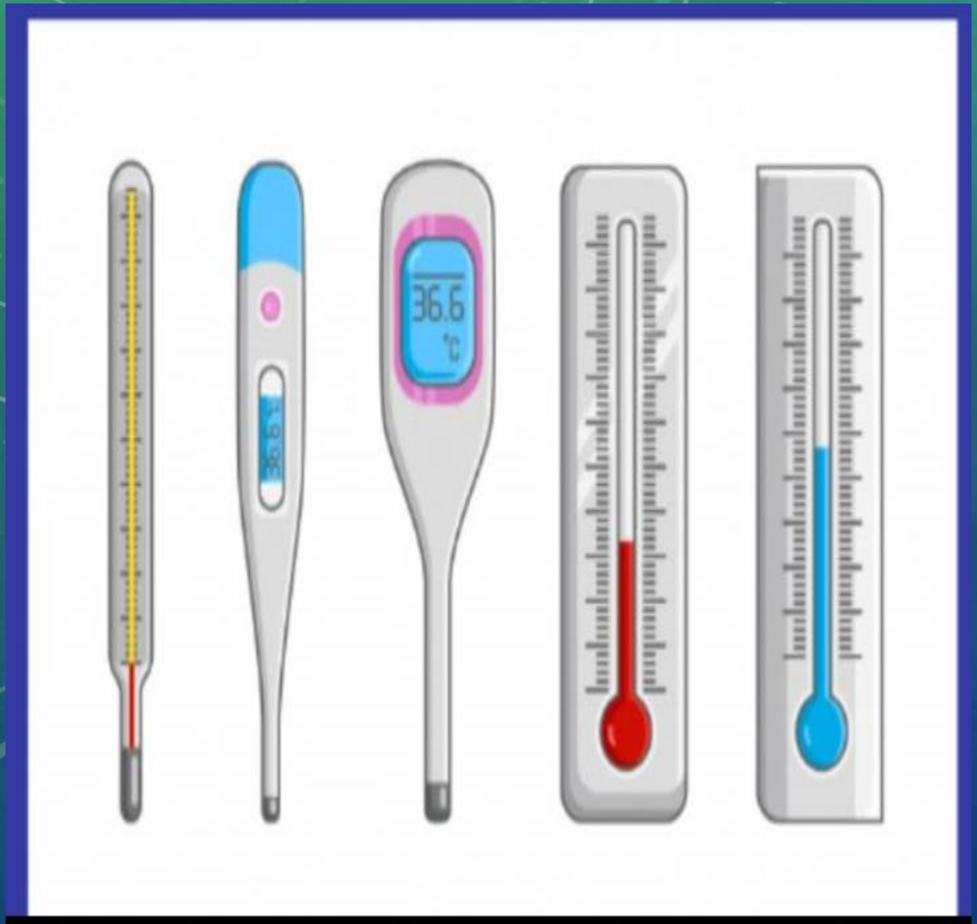
B.Sc. First Year

UNIT: I

THERMOMETRY



BY

BHANUDAS NARWADE

ASST.PROF.

DEGLOOR COLLEGE,DEGLOOR

THERMOMETRY:

Thermometry:

Branch of heat pertaining to measurement of temperature of body

Thermometer:

Instrument used to measure the temperature of body

Types of Thermometers:

1. **Liquid thermometer**

Principle: Change in volume of liquid with change in temperature

Example: Mercury, alcohol

THERMOMETRY:

2. Gas thermometers:

Principle: change in pressure or volume with change in temperature

Example : Hydrogen , Calander's constant pressure thermometer

3. Resistance Thermometers:

Principle : change of resistance with change of temperature

Example : Platinum resistance thermometer

4. Thermoelectric thermometer :

Principle: Thermoelectricity (production of thermo emf in thermocouple when two junctions are at different temperature

THERMOMETRY:

Various thermocouples are

Copper – constantan　　Iron –constantan　　Platinum-Rhodium

5. Radiation Thermometers:

Principle: quantity of heat radiations emitted by a body

Examples: Furnaces known as pyrometers

6. Vapour Pressure Thermometers :

Principle: change of vapour pressure with change in temperature

Used to measure very low temperature

Example: Helium vapour pressure thermometer

THERMOMETRY:

7. Bimetallic thermometers:

Principle : Expansion of solids

Used in meteorology ,day time and at higher altitude

8. Magnetic Thermometer:

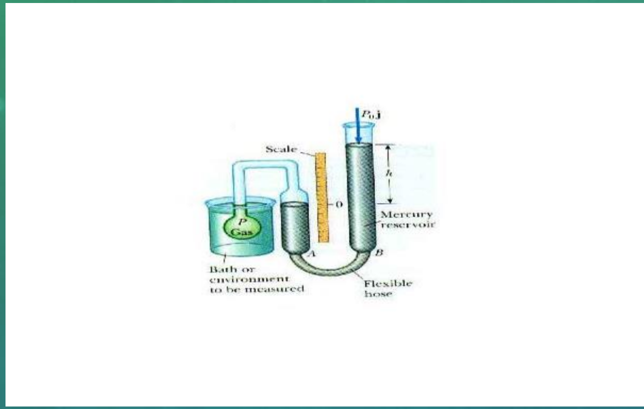
Principle: change in susceptibility of a substance with temperature

Used for low temperature near absolute zero

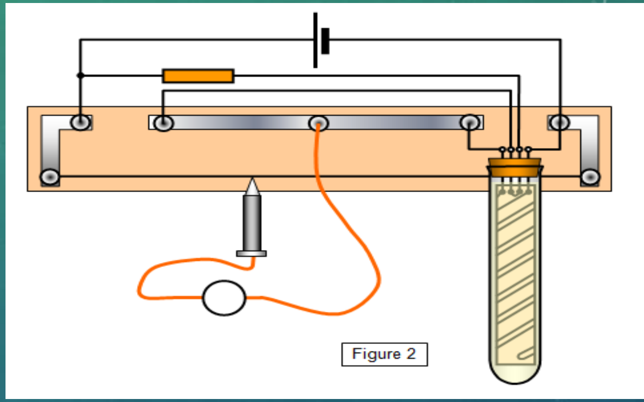
THERMOMETRY:

Liquid Thermometer

Gas Thermometer



Resistance Thermometer



Termoelectric Thermometer

Radiation Thermometer

Vapour pressure Thermometer

CENTIGRADE, FAHRENHEIT AND RANKINE SCALES:

First thermometer was constructed by Galileo in 1593

Newton suggested necessity of fixed scales

Temperature of melting point (MP) of ice as lower fixed point

Steam point(BP) of water as Upper fixed point at normal pressure

CENTIGRADE, FAHRENHEIT AND RANKINE SCALES:

1. Centigrade (Celsius) scale :

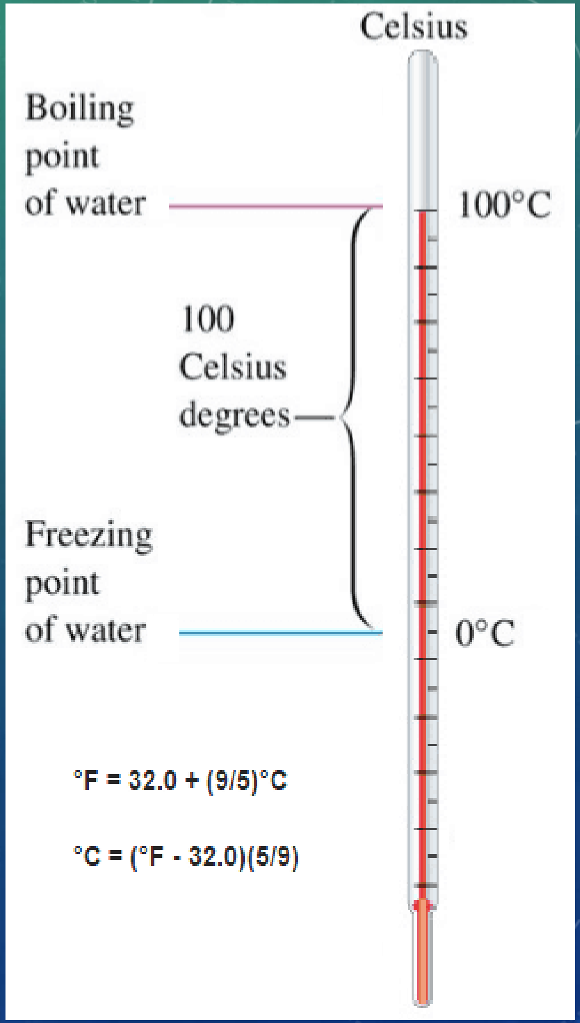
Celsius(1742) suggested the centigrade scale

Lower fixed point (MP) of ice is at zero

Upper point (BP) of water is at 100

Interval between two fixed point is equally divided by 100

Each point is 1^0 C



CENTIGRADE, FAHRENHEIT AND RANKINE SCALES:

2. Fahrenheit scale :

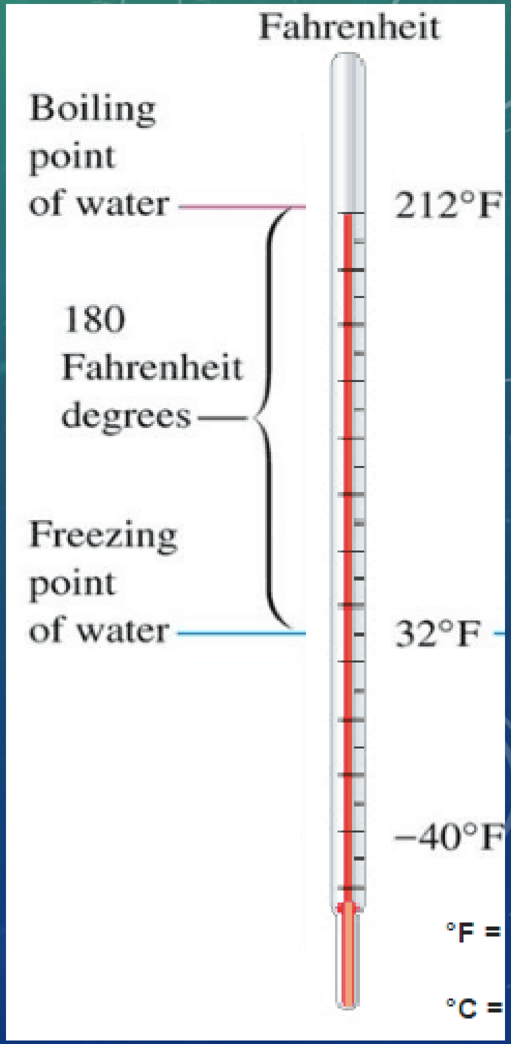
Fahrenheit (1720) suggested the Fahrenheit scale

Lower fixed point (MP) of ice is at 32

Upper point (BP) of water is at 212

Interval between two fixed point is equally divided by 180

Each point is 1^0 F



CENTIGRADE, FAHRENHEIT AND RANKINE SCALES:

3. Kelvin scale :

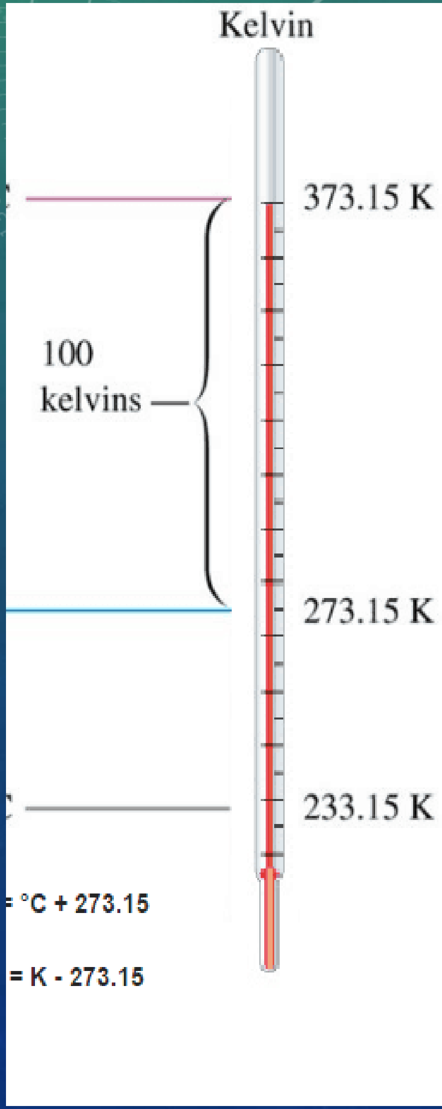
Kelvin suggested the Kelvin scale

Lower fixed point (MP) of ice is at 273

Upper point (BP) of water is at 373

Interval between two fixed point is equally divided by 100

Each point is 1 K



CENTIGRADE, FAHRENHEIT AND RANKINE SCALES:

4. Rankin scale :

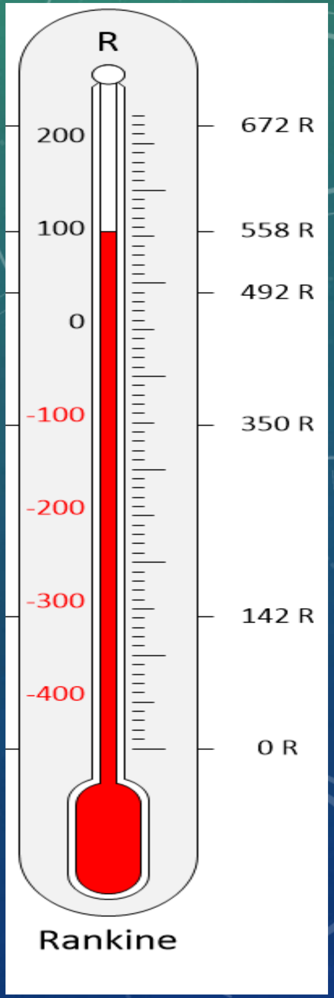
Rankin suggested the Rankin scale

Lower fixed point (MP) of ice is at 492

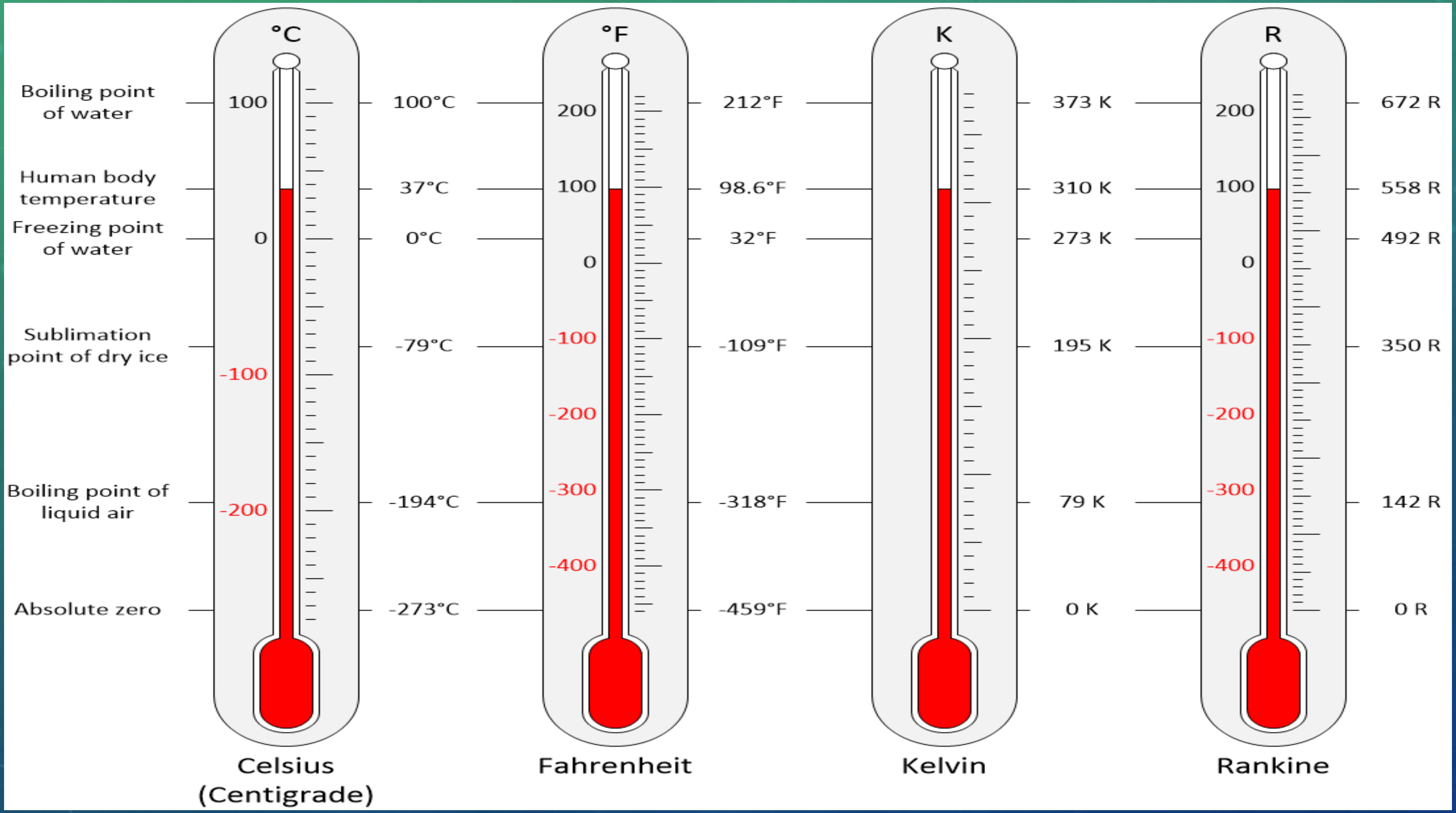
Upper point (BP) of water is at 672

Interval between two fixed point is equally divided by 180

Each point is 1^0 R



TEMPERATURE SCALES:



RELATION BETWEEN TEMPERATURE SCALES:

$$\frac{C-0}{100}=\frac{F-32}{180}=\frac{K-273}{100}=\frac{R-492}{180}$$

PROBLEMS:

1. **The temperature of the surface of the sun is about 6500 ^{0}C. What is this temperature i) on Rankine scale and ii) Kelvin scale**

Solution:

Given : C=6500^{0}C R=? K=?

$\frac{C-0}{100}=\frac{R-492}{180}$ $= R-492 = \frac{C}{100}\times180$

$= \frac{6500\times180}{100} = 11700$

R $= 11700+492=12192^0R$

$\frac{C-0}{100}=\frac{K-273}{100}$ $= 6500+273= 6773K$

$$\frac{C-0}{100}=\frac{F-32}{180}=\frac{K-273}{100}=\frac{R-492}{180}$$

PROBLEMS:

PROBLEMS:

2. Normal B.P. of liquid oxygen is -1830C. What is this temperature on Kelvin and Rankine scale

Solution:

Given : **C=-183^{0}C** **K=?** **R=?**

$\frac{C-0}{100}=\frac{K-273}{100}$ = -183+273= 90K

$\frac{C-0}{100}=\frac{R-492}{180}$ $= R-492 = \frac{C}{100} \times 180$

= $\frac{-183\times180}{100}$ =-329.4

R = -329.4+492=162.6^{0}R

$$\frac{C-0}{100}=\frac{F-32}{180}=\frac{K-273}{100}=\frac{R-492}{180}$$

PROBLEMS:

PROBLEMS:

3. At what temperature do Kelvin and Fahrenheit scale coincides?

Solution:

Let x be the temperature at which Kelvin and Fahrenheit scale coincides

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

$$\frac{x-273}{100}=\frac{x-32}{180}$$ $=180\,x-273\times180$ $=100\,x$ -3200

$180\,x$ $-100\,x$ $=-3200+49140$

$80\,x$ = 45940

x = 45940/ 80 = **574.25**

574.25^0F = 574.25K

$$\frac{C-0}{100}=\frac{F-32}{180}=\frac{K-273}{100}=\frac{R-492}{180}$$

PROBLEMS:

PROBLEMS:

4. At what temperature do Celsius and Fahrenheit scale coincides?

Solution:

Let x be the temperature at which Ceisius and Fahrenheit scale coincides

$$\frac{C-0}{100}=\frac{F-32}{180}$$

$$\frac{x}{100}=\frac{x-32}{180} \quad =180\,x = 100\,x - 3200$$

$180\,x - 100\,x = -3200$

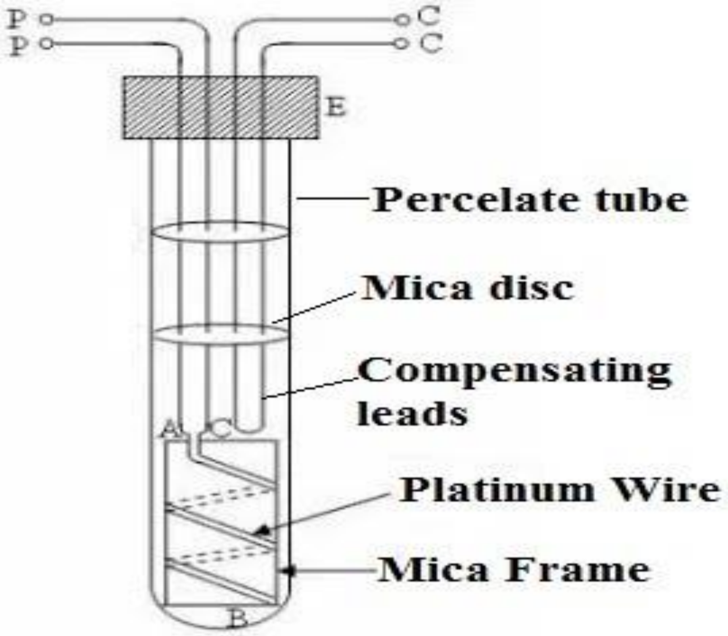
$80\,x = -3200$

$x = -3200/80 =$ **-40**

-40^0C = -40^0 F

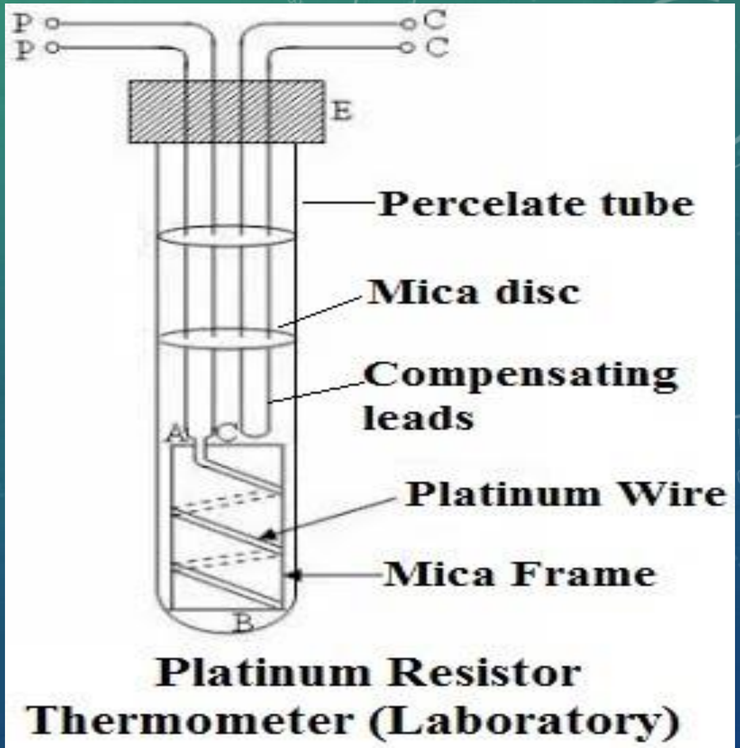
PLATINUM RESISTANCE THERMOMETER:

Principle: Change of resistance with change of temperature
Designed by Siemen in 1871 and improved by Callender and Griffiths
Construction: Pure platinum wire wound in double spiral to avoid inductive effect.
Wire is wound on mica plate
Two ends of platinum wire connected to thick copper leads
C C –compensating leads similar to platinum wire
Platinum wire and compensating leads enclosed in a percelate tube
Tube is sealed and terminals provided at top



Platinum Resistor Thermometer (Laboratory)

PLATINUM RESISTANCE THERMOMETER:



Resistance of wire at $t^0C = R_t$ and at $0^0C = R_0$

$R_t = R_0(1 + \alpha t + \beta t^2)$-------(1)

α and β are constants and depends on nature of material

To find α and β , resistance of platinum wire is determined at three fixed points

1) At MP of ice 2) BP of water 3) BP of sulphur (444.6^0C)

and BP of oxygen(-182.5^0C)

$R_{100} = R_0(1 + \alpha 100 + \beta(100^2)$

$R_{444.6} = R_0(1 + \alpha 444.6 + \beta(444.6^2)$

PLATINUM RESISTANCE THERMOMETER:

α *and* β can be determined $R_t = R_0(1 + \alpha t + \beta t^2)$

β is very small

$$R_t = R_0(1 + \alpha t)$$

$$R_{100} = R_0(1 + \alpha\, 100)$$

$R_t - R_0 = R_0 \alpha t$ ------(2)

$R_{100} - R_0 = R_0 \alpha 100$ ---(3)

Dividing eq. (2) by (3) $\frac{R_t - R_0}{R_{100} - R_0} = \frac{t}{100}$

OR $\boldsymbol{t = \left(\frac{R_t - R_0}{R_{100} - R_0}\right) \times 100}$

SEEBECK EFFECT:

Effect: Current flows in a circuit consisting of two dissimilar metals when one junction is heated while other is cold

No cell was used

Experiment of thermocouple of Fe and Cu

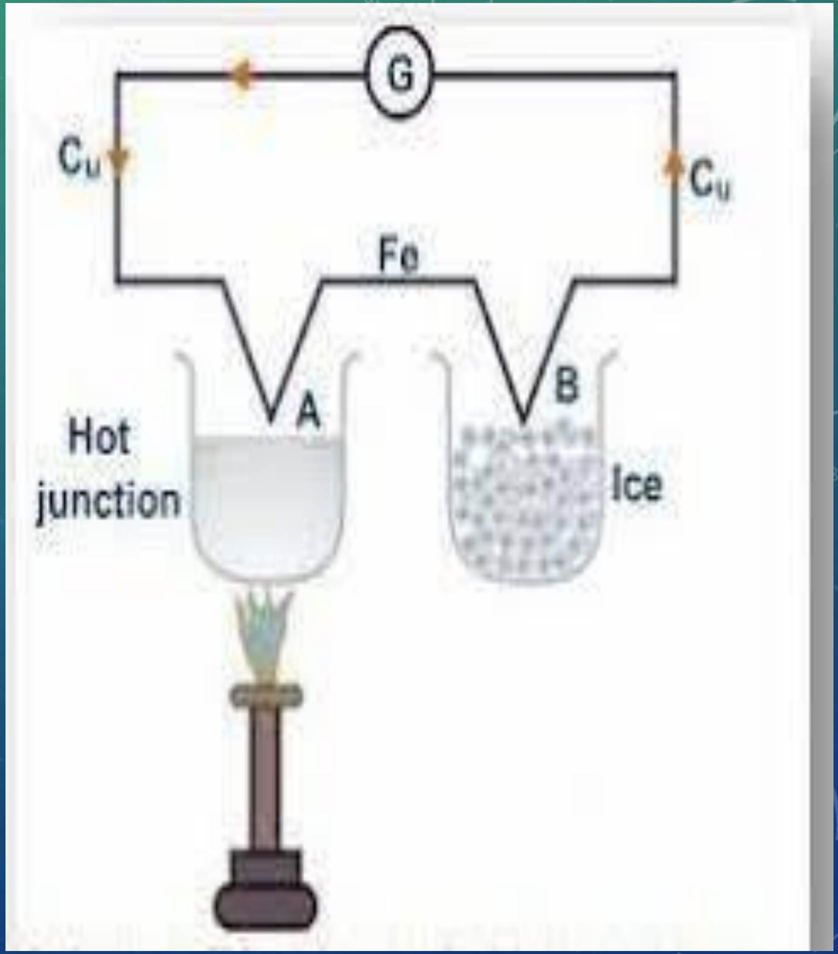
When both junctions are at 0^0C , No deflection in galvanometer

When one junction is at 0^0C and other heated gradually ,Current flows in circuit

Current flows from Cu to Fe at hot junction and Fe to Cu at cold junction

Current increases until hot junction at 270^0C. Beyond it current decreases and finally at 540^0C current is zero.

Beyond 540^0C , direction of current reversed



SEEBECK EFFECT:

Current produced without cell or battery is thermo-electric current and branch thermoelectricity and effect Seebeck effect.

Neutral Temperature (t_n):

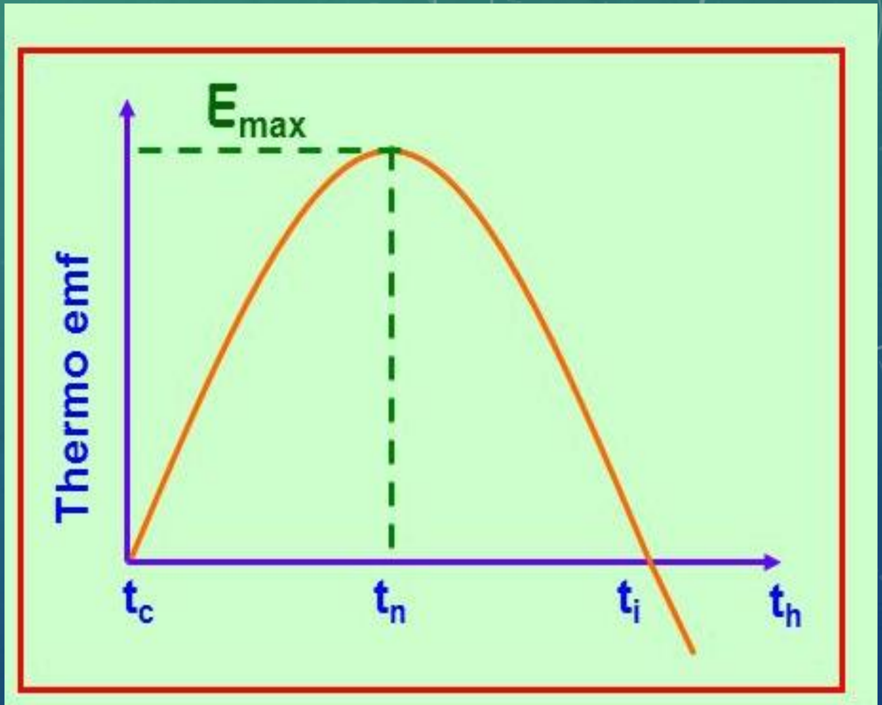
The temperature of hot junction at which maximum current(thermo emf) flows in the circuit called neutral temp. for that couple.

It does not depends upon temp of cold junction

Temperature of inversion(t_i):

Temperature of hot junction at which current (thermo emf) becomes zero and changes direction called temperature of inversion

Depends on temp of cold junction



$$t_n = (t_i + t_c) / 2$$

CAUSES OF SEEBECK EFFECT:

Seebeck effect explained on the basis of electron theory

There are always free electrons present in metals

Number of free electrons are different for different metals

When two dissimilar metals are joined to form junction, tendency of free electrons of one metal to diffuse into other

Flow continuous until contact P.D. is high enough

When junction is at same temperature, contact P.D. is zero


Thank
You!
©2013 RLS Photography