Thermometry

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Heat

It is a form of energy that changes the thermal condition of body. It flows from a body at higher temperature to a body at lower temperature.

Temperature

Degree of hotness or coldness of body which is determined by mean or average KE of each molecule.

Fixed Points

Lower Fixed Point

Temperature at which pure ice melt at normal pressure

Upper Fixed Point

Temperature at which pure water boils at normal pressure

Scales

- Celcius scale
  Lower fixed point = 0° C & upper fixed point = 100° C
- Fahrenheit scale
  Lower fixed point = 32° F & upper fixed point = 212° F
- Reaumer scale
  Lower fixed point = 0° R & upper fixed point = 80° R
- Absolute scale (Kelvin)
  Lower fixed point = 273 K & upper fixed point = 373 K
- Rankine scale
  Lower fixed point = 492 R & upper fixed point = 672 R

Now,

$$\frac{C-0}{100-0}=\frac{F-32}{212-32}=\frac{R-0}{80-0}=\frac{K-273}{373-273}=\frac{Rn-492}{672-492}$$

$$\text{or, } \frac{\mathrm{C}}{100}=\frac{\mathrm{F}-32}{180}=\frac{\mathrm{R}}{80}=\frac{\mathrm{K}-273}{100}=\frac{\mathrm{Rn}-492}{180}$$

Thermometers

1. Liquid thermometers
   Based on expansion of liquid on heating
   A. *Mercury thermometer*
   Mercury is used in thermometer due to
   - low specific heat capacity
   - high thermal conductivity
   - Uniform expansion over wide range
   - Can measure -39°C to 357°C
   - Does not stick on wall of tube and shining nature

   B. *Alcohol thermometer*
   It is used in cold region and high mountain where it can measure – 117° C to 78° C

2. Gas thermometers
   It is based on change in pressure at constant volume is directly proportional to change in temperature ie. Gay Lussac law
   - Most sensitive thermometers
   - Can measure -268° C to 1500° C
   - 'He' gas is used so

     $$\frac{t-\theta_1}{\theta_2-\theta_1}=\frac{\mathrm{P_t}-\mathrm{P}_{\theta_1}}{\mathrm{P}_{\theta_2}-\mathrm{P}_{\theta_1}}$$

     $\mathrm{P_t}=$ Pressure at $\mathrm{t}^0\mathrm{c}$

3. Resistance thermometer
   It is based on variation of resistance of conductor with temperature by $R_\theta = R_0(1 + \alpha\,\Delta\,\theta)$
   - Pure platinum is used since it has high value of temperature coefficient
   - Can measure -200° C to 1200° C

   Now,
   $$\frac{\mathrm{T} - \theta_1}{\theta_2 - \theta_1} = \frac{R_t - R_{\theta 1}}{R_{\theta 2} - R_{\theta 1}}$$
   $$R_t = Resistance at t^o C$$

4. Thermocouple thermometer
   It is based on variation of thermoemf in thermocouple with temperature by $e = A\theta + B\theta^2$ i.e. Seebeck effect, where A & B are constants whose value depends on nature of metal in thermocouple.
   - Can measure -200° C to 1600° C
   - B << A so e = Aθ

   $$\therefore \frac{\mathrm{t}}{\theta} = \frac{\mathrm{e_t}}{\mathrm{e_\theta}}$$

5. Pyrometer
   - *Radiation pyrometer*
     It is based on Stefan's law of black body radiation
     - Used to measure temperature above 800° C
     - Can measure the temperature of source at any distance
   - *Disappearing filament pyrometer*
     It is based on the filament of bulb when seen by filter disappear when its temperature is equal to distance object emitting radiation.
     - Can measure 600° C to 2700° C

6. Vapour pressure thermometer
   It is based on saturated vapour pressure of liquid varies with temperature by
   $$\log \mathrm{P} = \mathrm{a} + \mathrm{bt} - \frac{C}{T}$$
   a, b, c are constant & *T* = Absolute temperature
   - Can measure 0.71 K to 122K

7. Magnetic thermometer
   It is based on variation of magnetic susceptibility with temperature (Curie Law)
   - Used to measure temperature near about absolute zero.