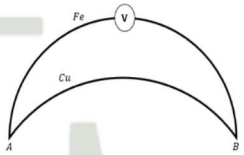
∅ ***Temperature of inversion:*** *The temperature of hot junction at which the thermo-emf becomes zero and changes its polarity is known as temperature of inversion (θi). Its value depends on: Nature of metal used in thermocouple and also depends upon the temperature of cold junction.*

∅ ***Thermoelectric Power (P) or Seebeck Coefficient (S)****: The rate of change of thermo-emf with temperature (of hot junction) is called as Seebeck coefficient or thermoelectric power. At neutral temperature, the thermoelectric power is zero.*

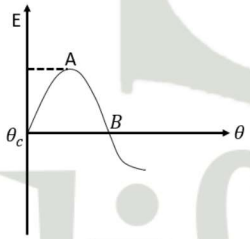
∅ ***Peltier Effect:*** *When an electric current is passed through a thermocouple, heat is either evolved or absorbed at the junction, depending upon the direction of flow of current. This effect is called Peltier effect.*

∅ ***Thermopile:*** *A thermopile is a device works on the principle of thermoelectric effect which is used to measure the intensity of radiation. It is made by connecting number of thermocouples in series. The thermocouples are made of Bismuth (Bi) and Antimony (Sb)*

1. a) What do you mean by thermoelectricity? On what factor does Thermoemf depend.
   b) Discuss the variation of thermoelectric emf with temperature of hot junction.
   c) The neutral temperature of a thermocouple is 120^oC. The electromotive force changes sign at 400^oC. Find the temperature of cold junction.
   d) Differentiate Seebeck's effect and Peltier's effect.
   e) The Thermoemf E and the temperature of hot junction θ satisfy the relation: $E = a\theta + b\theta^2$, where $a = 4.1x10^{-5}V°C^{-1}$ and $b = -4.1x10^{-8}V°C^{-2}$. If the cold junction temperature is 0^0C find the neutral temperature.
   f) What is thermopile. Describe the working of thermopile.
   g. Does thermoelectric series obeys law of conservation of energy?
   h. Define neutral temperature and temperature of inversion. Write the factors on which neutral temperature and temperature of inversion depends.
   i. What is the significance of thermoelectric series.
2. The figure below shows a $\boldsymbol{Fe - Cu}$ thermocouple with junctions at points A and B.
   a. Redraw the diagram and assign the hot and cold junction and also assign an arrow for the direction of current.
   b. Mention the factor(s) on which the neutral temperature depends.

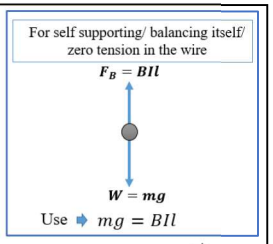


3. In the graph below.
   a. What is the temperature at points A and B called in thermoelectric effect?
   b. If value of A and B are $320K$ and $500K$, what must be the value of θ_c?
   c. For emf, $E = 10\theta - \frac{3}{100}\theta^2$, What could be the emf at neutral temperature, as given in (b).



Magnetic Field

- ✓ *Force on a moving charge due to magnetic field:* $\boldsymbol{F = Bqv \sin\theta}$
- ✓ *Lorentz Force:* $\boldsymbol{F = qE + Bqv \sin\theta}$, If $\vec{E} = 0$, Lorentz force $\boldsymbol{F = Bqv \sin\theta}$
- ✓ *Magnetic Force on a Current Carrying Conductor:* $\boldsymbol{F = BIl \sin\theta}$ & $\boldsymbol{I = v_d enA}$
- ✓ *Torque on rectangular coil in uniform field*: $\boldsymbol{\tau = BINA \cos\theta}$ **'or'** $\boldsymbol{\tau = BINA \sin\alpha}$ Where θ is angle bet'n plane of coil and $\vec{B}$ and α is angle bet'n area vector and $\vec{B}$



- ✓ *Current Sensitivity* $\frac{\phi}{I} = \frac{BNA}{K}$ *Voltage sensitivity* $\frac{\phi}{V} = \frac{BNA}{RK}$, R is resistance of coil
- ✓ *Hall Voltage:* $\boldsymbol{V_H = \frac{BI}{net}}$, : $\boldsymbol{V_H \propto \frac{1}{n}}$ Hall coefficient $\boldsymbol{H_c = \frac{1}{ne}}$
- ✓ *Biot-Savarts law:* $\boldsymbol{dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}}$ *(Scalar form)* $\boldsymbol{\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{I(\vec{dl}x\vec{r})}{r^3}}$ (Vector form)
- ✓ *Magnetic field due: to current carrying circular coil: i)* At center: $\boldsymbol{B = \frac{\mu_0 NI}{2a}}$

  ii) on the axis of the coil: $\boldsymbol{B = \frac{\mu_0 NIa^2}{2(a^2+x^2)^{3/2}}}$, where, $\boldsymbol{a}$ is radius of coil & $\boldsymbol{x}$ is distance from center to the point along the axis. **If** $\boldsymbol{x = a}$**, then,** $\boldsymbol{B = \frac{\mu_0 NI}{\sqrt{32}a}}$

  iii) Long straight conductor: $\boldsymbol{B = \frac{\mu_0 I}{4\pi a}[\sin\alpha_2 + \sin\alpha_1]}$

  iv) Long solenoid: $\boldsymbol{B = \mu_0 nI}$ *(center) & at one End:* $\boldsymbol{B = \frac{1}{2}\mu_0 nI}$
- ✓ *Ampere's Circuital Law: It states that the line integral of magnetic field intensity over a closed path in free space is equal to* $\boldsymbol{\mu_0}$ *times the net current enclosed by the closed path. i.e.* $\boldsymbol{\oint \vec{B}.\vec{dl} = \mu_0 I_{en}}$
- ✓ *Force per unit length bet'n two parallel current carrying conductor:* $\boldsymbol{F = \frac{\mu_0 I_1 I_2}{2\pi a}}$

1. Fundamental nature of magnetism is the interaction of moving charge.
   a) What is Lorentz force. Write the vector representation of Lorentz force?
   b) Derive the expression for force on a moving charge due to magnetic field.
   c) Can a charged particle move through a magnetic field without experiencing any force?
   d) Can a constant magnetic field set an electron at rest into motion? Explain.
   e) An electron of KE $10eV$ is moving in a circular orbit of radius $11cm$, in a plane at right angles to a uniform magnetic field. Determine the value of flux density.
2. When a current carrying conductor placed in magnetic field, the conductor experiences magnetic force, derive an expression for force experienced by conductor placed in magnetic field.
   a) A straight conductor of length 5 cm carries current of 1.5A. The conductor experiences a magnetic force of $4.5x10^{-3}$N when it is placed in a magnetic field of 0.9 T. What angle the conductor makes with magnetic field?
   b) A copper wire has 10^{29} free electrons per cubic meter, a cross sectional area of $2mm^2$ and carries a current of $5A$. Calculate the force acting on each electron if the wire is now placed in a magnetic field of flux density $0.15T$ which is perpendicular to the wire.