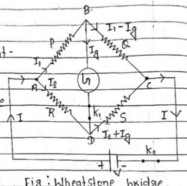
What is wheatstone bridge? Describe its balanced condition using kirchhoff's law and principle?

Ans: Wheatstone bridge:

=> An electrical circuit, which can be used for accurate measurment of resistance of a conductor, is called wheatstone bridge.

Ans: Principle

=> The principle of wheatstone bridge is, when the bridge is balanced the product of opposite arms are equal.



=> The current flowing through the galvanometer can be changed by varying the resistance 'R'

Fig: Wheatstone bridge.

for particular value of resistance R, the current flowing through the galvanometer (I_g) becomes zero.

=> This condition of the bridge is termed as null condition. In null deflection, the brige is said to be balanced. the balacing condition of bridge is

$$\frac{P}{Q} = \frac{R}{S} \quad \text{---(i)}$$

If 'S' is unknow resistance, then

$$\therefore S = \frac{Q}{P} \times R \quad \text{---(ii)}$$

Ans: Balancing condition:

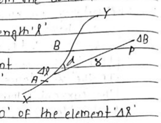
=> Suppose 'I' be the current at the juction 'A' this current is divided as I_1 be the fraction of current flowing through the resistance 'P' and I_2 be the

Law of Boit and Savart (Laplace's law).

=> The Boit and savart law is used to calculate the magnitude of magnetic field $\vec{B}$ produced by a current carrying conductor.

=> A result in electromagnetism states that the magnetic field intensity 'B' of a magnetic field produced by a current I in a long straight conductor is directly proportional to 'I' and inversely proportional to the perpendicular distance 'r' from the conductor.

=> Suppose a conductor 'XY' of length 'l' is carrying current 'I'



=> Suppose AB is a small element of the conductor of length 'Δl'

=> There is a point 'P' at a distance 'r' from the centre 'O' of the element 'Δl'

=> Suppose ΔB is the flux density of the magnetic field at a point 'P' do tue a small element 'Δl' according to Boit and savart law we can write,

$$\Delta B \propto I$$
$$\Delta B \propto \Delta l$$
$$\Delta B \propto \frac{1}{r^2}$$
$$\text{and } \Delta B \propto \sin\alpha$$

where, α is the angle between Δl and r.

On combaining these relation, we get,

$$\Delta B \propto \frac{I\Delta l \sin\alpha}{r^2}$$

$$\Delta B = \frac{kI\Delta l \sin\alpha}{r^2} \qquad \left[\because k = \frac{\mu_0}{4\pi}\right]$$

$$\therefore \Delta B = \frac{\mu_0}{4\pi}\frac{I\Delta l \sin\alpha}{r^2} \quad \text{---(i).}$$

b) Magnetic field at a point due to a long straight current carrying conductor.

=> Suppose a long straight conductor XY is carrying current 'I' there is a point at distance 'r' from a small current element AB of length Δl at which we have to find the value of magnetic field intensity 'B' as shown in figure. According to Boit and Savart law.

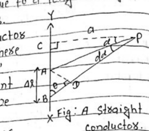


Fig: A straight conductor.

$$dB = \frac{\mu_0}{4\pi}\frac{Idl \sin\theta}{r^2} \quad \text{---(i)} \qquad \left|\begin{array}{l}\therefore \Delta l = dl \\ \Delta B = dB\end{array}\right|$$

In Δ ADB, we have,

$$\sin\theta = \frac{AD}{AB} \qquad (\because \sin\theta = P/h)$$

$$\sin\theta = \frac{AD}{\Delta l}$$

$$AD = \Delta l \sin\theta \quad \text{---(ii)}$$

In sector APD, we have,

$$d\alpha = \frac{arc}{radius} = \frac{AD}{r}$$

$$AD = r \cdot d\alpha \quad \text{---(iii)}$$

From eqn (ii) & (iii) we get,

$$\Delta l \sin\theta = r \cdot d\alpha$$

With these value equation (i) be-comes,

$$\Delta B = \frac{\mu_0}{4\pi}\frac{Idl}{r^2} \times \sin\theta$$

$$= \frac{\mu_0}{4\pi}\frac{Ird\alpha}{r^2}$$

$$\therefore \Delta B = \frac{\mu_0}{4\pi}\frac{Id\alpha}{r} \quad \text{---(iv)}$$

What is electric potential? Describe an expresion for electric potential due to a point charge?

Ans: Electric potential 'V':

=> "The electric potential at a point inside the electric field is defined as the amount of work done in moving a unit positive (test) charge from infinity to that point". i.e, $V = W_{\infty P}$.

where, $W_{\infty P}$ is the amount of workdone.

Derivation:

=> Suppose a point 'p' lies at distance 'r' from a point charge +q at which we have to find the value of electric potential as shown in figure.

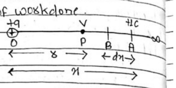


Fig: electric potential due to a point charge.

=> Suppose a unit positive charge lies at any point 'A' so that $OA = x$. since the force expreieced by unit positive charge is equal to the electric field intensity at the point.

$$\text{i.e. } F = \frac{1}{4\pi\varepsilon_0}\frac{q}{x^2}$$

Thus, the small work done in moving a unit positive charge from point A to point B so that $AB = dx$ is,

$$dw = \text{force} \times \text{displacement}.$$

$$\text{or, } dw = F \times (-dx)$$

$$\text{or, } dw = -\frac{1}{4\pi\varepsilon_0}\frac{q}{x^2} \times dx \quad \text{---(i)}$$

$$\therefore dw = \frac{-q}{4\pi\varepsilon_0}\frac{dx}{x^2} \quad \text{---(i)}$$

Here, negative sign show that force on the unit positive charge and its displacement is in opposite direction.

What is potential difference? Drive an expression for potential difference between two points.

=> Ans: potential difference: (P.d)

=> "The potential difference between two points inside the electric field is defined as the amount of work done in moving a unit positive charge from one point to another against the electric field".

=> If W_{BA} is the amount of work done in moving the unit positive charge from point B to point A, then it is equal to the potential difference (P.d) between two point A & B

$$\text{i.e. } \Delta V = V_{PQ} = W_{QP}.$$

Derivation:

=> Suppose two points P and Q lies at distances 'r' and 'R' respectively from a point charge +q at which we have to find the value of potential difference between two point shown in figure.

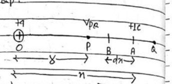


Fig: Potential difference due to a point charge.

> Suppose a unit positive charge (+1C) lies at any point 'A' so that $OA = x$. since the force expeieced by a unit positive (test) charge is equal to the electric field intensity of that point. i.e, $F = \frac{1}{4\pi\varepsilon_0}\frac{q}{x^2}$

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Here, negative sign shows that force on the unit positive charge and its displacement in opposite direction.

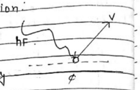
Define photoelectric effect.? Drive einsteinst's equation for photoelectric effect.

Ans: photoelectric effect:

=> "The phenomenon of emission of electrons from a surface of metal when electromagnetic radiation (light) of suitable frequency incident on it is called photoelectric effects."

Ans: Einstein's photoelectric equation:

=> According to plank's quantum theory of radiation, the energy associated with each photon of light with frequency 'F' is given by



$$\therefore E = hF \quad \text{---(i)}$$

where, 'h' is the planck's constant.

=> When a photon of energy 'hF' in incident on a metal surface, it is used in two ways:

a) A part of this energy is used to knock out an electron from its atom. The minimum energy requiired just to liberate an electron from the surface of metal without imparting any k.E. to it is called work function 'ϕ' of the metal.

b) The rest of the energy is used in providing the k.E to ejects photoelectrons 'kE'. if 'm' is the mass and 'v' is the velocity of the photoelectron after the emission, the k.E. of the emitted photoelectron is given by,

$$k.E = \frac{1}{2}mv^2 \quad \text{---(ii)}$$

From above disscussion, we can write.

$$hF = k.E + \phi$$

$$\therefore hF = \frac{1}{2}mv^2 + \phi \quad \text{---(iii)}$$

This equation is know as Einstein's photoelectric eqn.

Write the Newton's formula for the velocity of sound in air (gas). How did laplace correct this equation?

=> Ans: Newton's Formula:

=> According to Newton, when sounds waves propagate through gas, compression and rare faction are produced in the gas medium. The temperature variations in the region of the compression and rare fraction are negligible therefore, the process is an isothermal process. the equation of state for the isothermal change is given by,

$$PV = nRT$$

$$PV = k \text{ (constant)}. \quad \text{---(i)}$$

where, 'p' is pressure and 'v' is volume of the air.

On differentiating equation (i) we get,

$$pdv + vdp = 0$$

$$\text{or, } pdv = -vdp$$

$$\text{or, } p = -\frac{vdp}{dv} = \frac{-dp}{dv/v}$$

$$\text{or, } P = -\frac{\text{stress}}{\text{strain}} = -k_{iso} \quad \text{---(ii)}$$

where, k_{iso} is isothermal bulk modulus of elasticity. Negative sign indicates that as the pressure on air increases its volume is decreases or vice-versa.

Hence, the Newton formula for velocity of sound is given by,

$$V = \sqrt{\frac{k_{iso}}{\rho}} = \sqrt{\frac{P}{\rho}} \quad \text{---(iii)}$$

where, P is the pressure and 'ρ' is its density.

For N.T.P. we have,

$$P = 1.013 \times 10^5\ Nm^{-2}$$

$$\text{and } \rho = 1.293\ kgm^{-3}$$

Now,

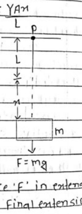
$$V = \sqrt{\frac{P}{\rho}} = \sqrt{\frac{1.013 \times 10^5}{1.293}} = 280\ ms^{-1}$$

Energy stored in a stretched wire?

=> When a deforming force is applied to a wire it is extended against restoring force set up in the wire due to its elasticity, thus. the applied force works against the restoring force. This work-done by a deforming force is stored as potential energy in the wire.

To calculate energy stored in a stretched wire consider a wire of length 'L' subspended from point 'P'. 'A' be the area of cross section of the wire. A mass is attached at its lower end. therefore, mg is the deforming force 'F' applied to the wire. let x be the young's modulus of elasticity of material of the wire then,

$$Y = \frac{F/A}{x/L} = \frac{FL}{xA} \Rightarrow F = \frac{YAx}{L}$$



If dx is the futher small extension, the small work done 'dw' is given by,

$$dw = \text{force} \times \text{displacement}$$

$$dw = F \times dx$$

$$\therefore dw = \frac{YAx}{L} \times dx$$

=> The total work done by deforming force 'F' in extending the wire from intial extension '0' to final extension 'e' is

$$W = \int_0^e dw = \int_0^e \frac{YAx}{L}dx$$

$$= \frac{YA}{L}\int_0^e x\,dx$$

$$= \frac{YA}{L}\left[\frac{x^2}{2}\right]_0^e$$

What is radioactivity? state law of radio-active disintegration and that $N = N^0 e^{-\lambda t}$, where, the symbols carry their usual meanings.

Ans: Radioactivity:

=> The phenomenon of spontaneous emission of heghly penetrating radiations, α-, β-, and γ-rays from the elements of atomic weights 'A' greater than about 206 is called radioactivity.

Ans: law of radioactive Disintegration:

=> a) Atoms of every radioactive substance are constantly disantigrating into fress radioactive products whith the emission of α, β and γ-rays.

b) The rate of disintegration is independent of external factor like, temperature, pressure, chemical combination etc.

c) The rate of disintegration of radioactive substance at any instant of the time is directly proportional to the number of atoms precents that instant of time.

Derivation relation $N = N^0 e^{-\lambda t}$.

=> Suppose 'N' be the number of atoms present in a particular radioactive element at any instant of time 't' If dN is the number of disintexigation of time 'dt' then,

$$\text{rate of disintegration} \propto N$$

$$\text{or, } \frac{dN}{dt} \propto N$$

$$\therefore \frac{dN}{dt} = \lambda N \quad \text{---(i)}$$

Where, λ is called decay (or disintegration) constant. The negative sign show that the number of present atom is contineously decreasing with time.