Energy of an electron in the n^{th} orbit?

=> Total energy of an electron in the n^{th} orbit is equal to the sum of kinetic energy due to motion of the electron and potential energy due to the position of the negatively charged electron near the positively charged nucleus.

i) K.E :- If 'v' be the velocity of electron with mass 'm', its kinetic energy is,

$$K.E = \frac{1}{2} mv^2$$

or, $K.E = \frac{1}{2} m \left(\frac{1}{4\pi\varepsilon_0} \times \frac{Ze^2}{mr}\right)$

From orbital velocity of electron.

$$mv^2 r = \frac{Ze^2}{4\pi\varepsilon_0}$$

$$v^2 = \frac{Ze^2}{4\pi\varepsilon_0 mr}$$

$$\therefore v^2 = \frac{1}{4\pi\varepsilon_0} \frac{Ze^2}{mr}$$

$$\therefore K.E = \frac{1}{8\pi\varepsilon_0} \times \frac{Ze^2}{r} \text{ ----(i)}$$

ii) potential energy (P.E):- The potential energy of an electron of charge (-e) is

$$P.E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze.(-e)}{r} \text{ ......(ii)}$$

$$\therefore P.E = -\frac{1}{4\pi\varepsilon_0} \frac{Ze^2}{r} \text{ ---(ii)}$$

Hence, the energy of the electron is,

$$E_n = K.E + P.E$$

$$= \frac{1}{8\pi\varepsilon_0} \times \frac{Ze^2}{r} + \frac{1}{4\pi\varepsilon_0} \frac{Ze^2}{r}$$

$$= \frac{Ze^2}{\pi\varepsilon_0 r}\left(\frac{1}{8} - \frac{1}{4}\right)$$

$$= \frac{Ze^2}{\pi\varepsilon_0 r}\left(\frac{1-2}{8}\right)$$

$$= -\frac{1}{8\pi\varepsilon_0} \cdot \frac{Ze^2}{r}$$

$$= \frac{-Ze^2}{8\pi\varepsilon_0} \times \frac{1}{r} \quad \left[\because r = \frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2}\right]$$

$$= \frac{-Ze^2}{8\pi\varepsilon_0} \cdot \frac{\pi m Z e^2}{\varepsilon_0 n^2 h^2}$$

$$\therefore E_n = -\frac{mZ^2 e^4}{8\varepsilon_0^2 n^2 h^2}$$

What are the Bohr's postulates of hydrogen atom? Derive an expression for the radius of Bohr's orbit?

=> Bohr's postulates are given below:

a) "An electron can occupy only those orbits in which the angular momentum is equal to integral multiple of $h/2\pi$.

i.e, $mvr = m\omega$

$$\therefore mvr = n\frac{h}{2\pi}$$

where, 'h' is planck's constant.
r is the radius of the circular orbit.
v is the velocity of the electron.
n is the quantum number, it may be 1, 2, 3, ...

b) "The electrons moves round nucleus in a circular path under the electrostatic force of attraction".

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0} \frac{Ze.e}{r^2} \text{ .....(i)}$$

where, $\varepsilon_0 = 8.85\times10^{-12} C^2N^{-1}m^{-2}$ is permittivity of free space (or air or vaccum). and $\frac{1}{4\pi\varepsilon_0} = 9\times10^9 Nm^2C^{-2}$.

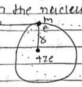
=> Radius of orbit for hydrogen atom:

=> suppose a hydrogen atom which has positive charge '+Ze' in the nucleus and negative charge 'e' moving round in an orbit of the radius 'r' as shown in figure.

=> suppose the electron revolving in the n^{th} orbit whose radius is r_n with velocity V_n

=> From coulomb's law of electrostatics, the electrostatic force of attraction between the nucleus and the electron is given by.

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Ze.e}{r_n^2}$$



$$\varepsilon_0 = 8.85\times10^{-12} N^{-1} C^2 m^{-2}.$$

=> When the key 'K' is open, i.e. open circuit, there is no current flowing through resistance 'R' and potential difference found is equal to emf 'E' of the cell.

=> In this condition, the balancing length of potentiometer is l_1. If 'L' is the total length of the wire then,

$$E = \frac{l_1}{L} V_0 \text{ -----(i)}$$

where, V_0 is the potential difference across whole length.

=> When key 'K' is closed, i.e, circuit is closed so that current flows through resistance 'R' as well, then the jockey point gives new balancing length l_2.

=> The potential difference 'V' in this case is equal to the potential drop across 'R' (as cell and 'R' are connected parallel)

so, $V = \frac{l_2}{L} V_0$ ----(ii)

On dividing equation (i) by equation (ii), we get,

$$\frac{E}{V} = \frac{l_1}{l_2} \text{ ----(iii)}$$

since, $E = I(R+r)$, $V = IR$.

with these values, the equation (iii) becomes,

$$\frac{I(R+r)}{IR} = \frac{l_1}{l_2}$$

or, $\frac{r}{R} = \frac{l_1}{l_2}$

or, $1 + \frac{r}{R} = \frac{l_1}{l_2}$

$$\therefore r = \left(\frac{l_1}{l_2} - 1\right) R \text{ ----(iv)}$$

By knowing the value of l_1, l_2 and R, the internal resistance 'r' of the given cell can be calculated by using potentiometer.

State and explain coulomb's law of electrostatics?

=> It states that "The force of attraction or repulsion between two electric charge is directly proportional to the product of their magnitude and inversally proportionall to to square of the distance between them.

=> Suppose two electric charge q_1 and q_2 is separated through a distance 'r' according to coulomb's law the force 'F' is experienced them is given by:

$$F \propto q_1 q_2 \text{ ---(i)}$$

and. $F \propto \frac{1}{r^2}$ ----(ii)

Now, on combaining these two equation, we get,

$$F \propto \frac{q_1 q_2}{r^2}$$

$$F = k\frac{q_1 q_2}{r^2}$$

Where, k is proporsanality constant whose value depends on the nature of madium and the system of unit chogen.

Define electrolysis:?

=> The process of decomposition of compound in the form of solution into consituent ions on passing direct current (D.C) through it called electrolysis.

Define electrostatic induction:?

=> The temporary electrification of a conductor when a charged body placed near it is called the electrostatic induction.

Define electric charge (Q)?

=> Electric charge is the property of a matter that causs it to exprience a force when placed in an electromagnetic field. electric charges are scalar, conserved and quantized quantities.

=> The charge on an electron being 1.602×10^{-19}.

$$\therefore E = W = \frac{q^2}{2C} \text{ ----(ii)}$$

moreover, using $q = CV$ we get,

$$E = \frac{(CV)^2}{2C}$$

$$= \frac{C^2V^2}{2C}$$

$$= \frac{CV^2}{2}$$

$$\therefore E = \frac{1}{2}CV^2 \text{ .....(iii)}$$

and $E = \frac{1}{2}\frac{q}{V}.V^2$

$$\therefore E = \frac{1}{2} qV \text{ --- (iv)}$$

$$E = \frac{1}{2}CV^2 = \frac{1}{2}qV = \frac{q^2}{2C} \text{ ----(V)}$$

This is the required expresion of energy stored by a charged capacitor.

Capacitor:

=> An arrangments of conductors separated by an insulator used to store charge is called capacitor. ⊣⊢ Fig: symbol.

=> In other word capacitor is an electrical component that used for store the electric charge in the circuit.

Capacitance.

=> The ability (or capacity) of capacitor (i.e conductor) to store electric charge is called capacitance of the capacitor.

=> It is measured in Farad (F).

=> It is denoted by 'C'.

i.e, $C = q/V$

The point P may be bright or dark fringes depending upon the path difference (BP−AP).

If the path difference is multiple of λ; then forms bright fringes.

i.e. $BP - AP = \frac{xd}{D} = n\lambda$ (where, n = 1, 2, 3, ----)

Hence, in general for n^{th} bright fringe.

$$x_n = \frac{n\lambda d}{d}$$

The distance for first bright fringe. i.e. n=1;

or, $x_1 = \frac{\lambda D}{d}$

The distance for second bright fringe. i.e, n=2;

$$x_2 = \frac{2\lambda D}{d}$$

Fringe width $x_2 - x_1 = \frac{2\lambda D}{d} - \frac{\lambda D}{d} = \frac{\lambda D}{d}$

This relation gives the fringe width.

Define interference of light?

=> The phenomenon of redistribution of light energy in a medium because of the superposition of light waves coming from two coherent source is called interference of light.

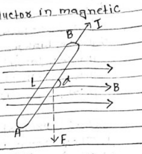
Condition for the interference:

=> The following condications should be fulfilled to observe the interference phenomenon of light.

a) The two source of light must be coherent.
b) The coherent source of light must emit waves contineously.
c) The coherent source of light must be closed to each other.
d) The coherent source of light must be narrow. (i.e, Fine slits).
e) " " " " " should emit monochromatic light.
f) The distance between coherent source of light and the screen must be large.

Force on a current carrying conductor in magnetic Field?

=> The magnitude of force 'F' on a current carrying conductor in a magnetic field is.



a) directly proportional to the magnetic field 'B'.

i.e, $F \propto B$

b) directly proportional to the current (I) flowing through the conductor

i.e. $F \propto I$.

c) directly proportion to the length 'L' of the conductor.

i.e, $F \propto L$.

d) directly proprotion to the sine of the angle 'α' between the conductor and applied magnetic field.

i.e, $F \propto \sin\alpha$.

On combaining these ~~two~~ relation we get,

$$F \propto BIL\sin\alpha$$

$$\therefore F = kBIL\sin\alpha \text{ ---(i)}$$

where, 'k' is a proporsanality constant. (k=1).

If B = 1 Tesla, I = 1A, L = 1m and α = 90° then F = 1N

so, k = 1

therefore equation (i) be-comes,

$$F = BIL\sin\alpha \text{ ---(ii)}$$

It is the required equation.

In the vector form equation (i) weget,

$$\vec{F} = I(\vec{L}\times\vec{B}) \text{ ....(iii)}$$

This force is perpendicular to the plane of $\vec{I}$ & $\vec{B}$.

State Hooke's law. How can you verify it experimently?

=> Hooke's law:

=> Whithin the elastic limit, the applied stress is proportional to the strain produced".

i.e, stress ∝ strain.

$$\therefore \frac{stress}{strain} = E$$

where, E is a constant and is called coefficient (or modulus) of elasticity.

Ans: verification of Hooke's law:

=> Suppose a spring of length 'L' suspended from a rigid support as shown in figure (a). A pointer 'P' slides over a scale. Fitted parallel to the spring; ~~so that~~

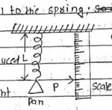


Figure (a)

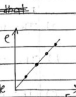


Figure (b)

A graph between the applied load 'F' and extension produced 'e' is drawn as shown in Figure (b) This is the straight line passing through the origin. This indicate that,

$$F \propto e$$

$$\therefore F = ke \text{ -----(i)}$$

On diving both side of equation (i) by A and also multiplying and dividing the R.H.S by L, we get,

$$\frac{F}{A} = \left(\frac{kL}{A}\right)\frac{e}{L}$$

since, cross sectional area A and L are constants, $\frac{kL}{A}$ is also constant.

$$\frac{F}{A} \propto \frac{e}{L}$$

i.e, stress ∝ strain (whithin the elastic limit).

This is the varification of Hooke's law in the laboratory.

Ohm's law and varification:

Statement: "The current flowing through a conductor is directly proportional to the potential difference across its two ends provided its other physical conditions remain unchanged".

=> Suppose 'V' be the potential difference across two ends of a conductor and 'I' be the current flowing through it. According to ohm's law,

i.e, $V \propto I$

$$\therefore V = IR$$

Where, 'R' is a constant and is called resistance of the conductor.

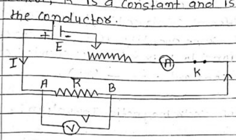


Fig:-(i) circuit diagram

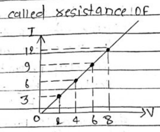


Fig: (ii) graph between current and voltage.

Figure: varification of ohm's law.

Varification:

=> The current 'I' and potential difference 'V' across resistance 'R' are noted from ammeter and voltmeter respectively by varying resistance of rheostat (RH)

=> A graph between 'V' and I plotted which is a straight line passing through the origion as show in Fig (ii) which proves that potential difference is directly proportional to the current flowing through it. Hence this is the verifies the ohm's law.