Name- Fardouse Lomat Jahan Rumpa

ID- 2219170041

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Ans to the Qus No: 01 (a)

Ans: Gauss law is a total flux lined with a close surface is $1/\varepsilon_0$ times the charge enclosed by the closed surface. For instance, if a point charge is placed inside a cube of edge "a", the flux through each face of the cube is $q/6\varepsilon_0$. This is what the guass law said. An electric field is known as the basic concept of electricity. It's typically calculated by applying coulomb's Law when the surface is needed. The gauss law helps to calculate the electric field distribution ~~ina~~ in a close surface.

Gauss law explain's the electric charge enclosed in a closed or electric charge present in the enclosed closed surface. So,

The Gauss law states that the net flux of an electric charge. This law is one of four equations of Maxwell's laws of electromagnetism.

Electric flux is known as the electric field passing through a given area multiplied by the area of the surface in a plane perpendicular to the field. Another statement of guass's law states that the net flux of a given electric field through a given surface, divided by the enclosed charge should be equal to a constant.

Gauss' Law

Electric flux
Nm^2/C

$$\boxed{\phi = \frac{Q}{\varepsilon_0}}$$

enclosed charge C

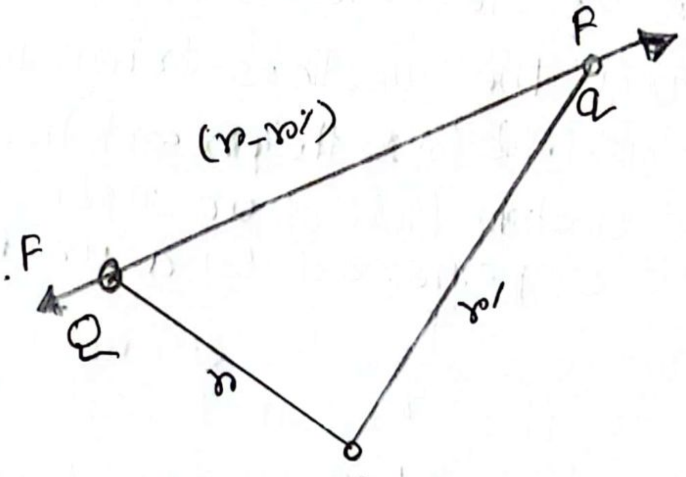
permittivity of free space (8.85×10^{-12})

Ans to the Qus NO: 01 (b)

Ans: Gauss' Law from Coulomb's Law:

Equivalence of gauss' Law for electric fields to coulomb's Law:

Coulomb's law is often one of the first quantitative laws encountered by students of electromagnetism. It describes the force between two point electric charg



Electric force.

It turns out that it's equivalent to Gauss's law. Colomb's Law states that the force between two static point electric charges is proportional to the inverse square of the distance between them. acting in the direction of a line connecting them. If the charges are of opposite signs the force is attractive and if the charges are of same sign, the force is repulsive.

Mathmatically, Coulomb's Law is written as

$$F = \frac{qQ}{4\pi\varepsilon_0 |r-r'|^2}\,\underline{\hat{r}},$$

where F is the force between the two charges q and Q, $|r-r'|$ is the distance between the charges and $\underline{\hat{r}}$ is a unit vector in the direction of the line sparating the two charges.

Having defined Coulomb's Law, One might next naturally ask the question how would a standard reference charge behave in the presence of any distribution of electric charge we might dream up? Answering the questions brings us to the concept of the electric field. We follow the presentation of |Gri99|. We can define the electric field of an arbitrary charge Q, as the force exeperienced by a unit charge q, due to Q

$$e = \frac{F}{q}$$

Dividing both sides of coulomb's Law by q and substituting the definition of e, we get that the electric field of a point charge Q is

$$e(r) = \frac{Q}{4\pi\varepsilon_0 |r-r'|^2}\,\underline{\hat{r}}$$

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It's important to note here that the electric field obeys the principle of superposition, meaning that the electric field of an arbitrary collection of point changes is equal to the sum of the electric fields due to each individual charge.

$$e\left(\sum_{k=1,n} Q_i\right) = \sum_{k=1,n} e\left(Q_i\right)$$

if we consider the the electric field due to a spatially extended body with change density ρ, the sum becomes an integral over infinitesimal valoume elements of the body.

$$e = \frac{1}{4\pi\varepsilon_0}\int_V \frac{\rho}{|r-r'|^2}\,\underline{r}\,dv,$$

where $|r-r'|$ is now the distance from a point in the charged body to the point at which the electric field is to be evaluated. The integal is over the charged body.

We can show that is equivalent to Gauss's Law directly from the definition of divergence,

$$\nabla\cdot e = \lim_{\Delta V\to 0}\frac{1}{\Delta V}\oint_S e\,da,$$

Where the integral is over S, the closed surface bounding the valeme ΔV, Applying this definition to the electric field of a point charge q at the origin gives

$$\nabla\cdot e = \lim_{\Delta V\to 0}\left[\frac{1}{\Delta V}\,\frac{q}{4\pi\varepsilon_0|r-r'|^2}\oint_S da\right]$$

Taking ΔV as a closed sphere of radius $|r-r'|$ centered at the origin, we can easily evaluate the integral, giving

$$\nabla\cdot e = \lim_{\Delta V\to 0}\left[\frac{1}{\Delta V}\cdot\frac{4\pi|r-r'|^2 q}{4\pi\varepsilon_0|r-r'|^2}\right]$$

$$= \lim_{\Delta V\to 0}\left[\frac{1}{\Delta V}\frac{q}{\varepsilon_0}\right]$$

in the limit $\Delta V\to 0$, $\frac{q}{\Delta V}$ is simply the charge density ρ. This establishes the desired result

$$\nabla\cdot e = \frac{\rho}{\varepsilon_0}.$$

~~For a more detailed discussion, see~~

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Ans to the Qus NO: 01 (c)

Answer: **Self inductance:**

When there is a change in the current or magnetic flux of the coil, an electromotive force is induced. This phenomenon is termed self inductance. When the current starts flowing through the coil at any instant, it is found that, that the magnetic flux becauses directly proportional to the current passing through the circuit. The relation is given as;

$$\phi = L \times I$$

where L is termed as the self-inductance of the coil or the coefficient of self-inductance, the self-inductance depends on the cross-sectional area, the permeabili of the material, and the number of turns in the coil. The rate of change of magnetic flux in the coil is given as,

$$e = -\frac{d\phi}{dt} = -\frac{d(LI)}{dt}$$

$$e = -L\frac{dI}{dt}$$

Self-inductance formula:

$$L = N\frac{\phi}{I}$$

Where, * L is the self inductance in Henries
* N is the number of turns.
* Q is the magnetic flux
* I is the current in amperes.

Mutual Inductance:

Consider two coils: P-coil (Primary coil) and S-coil (secondary coil). A battery and a key are connected or magnatic flux linked with the two coils, an opposing electromotive force is produced across each coil, and this phenomenon is termed Mutual Inductance.

This phenomenon is given by the relation:

$$\phi = MI$$

where M is termed as the mutual inductance of the two coil or the coefficient of the mutual inductance of the two coils.

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The rate of change of magnetic flux in the coil is given as,

$$e = -\frac{d\phi}{dt} = -\frac{d(MI)}{dt}$$

$$e = -M\frac{dI}{dt}$$

Mutual Inductance formula:

$$M = \frac{\mu_0 \mu_r N_1 N_2 A}{I}$$

Where *μ_0 is the permeability of free space.

* μ_r is the relative permeability of the soft iron core.
* N is the number of turns ~~of~~ in Coil.
* A is the cross-sectional area in m^2
* I is the length of the coil in m.

Self-inductance and Mutual inductance are both measured in Henry. They have a relation of $\sqrt{L_1 L_2} = M$.

Ans to the Que NO:02 (g)

Answer: Lenz's Law:

Lenz's Law named after the physicist Emil Lenz was formulated in 1831. It states that the direction of the current induced in a conductor by a changing magnetic field is such that the magnetic field created by the induced current opposes that initial changing magnetic field.

When a current is induced by a magnetic field, then the magnetic field produced by the induced current will create its magnetic field. Thus, this magnetic field will be opposed by the magnetic field that created it.

Lenz's Law is based on Faraday's Law of induction which says, a changing magnetic field when a current opposes the initial ~~and~~ changing magnetic field.

$$\epsilon = -\frac{d\varphi_B}{dt}$$

The magnetic field can be changed by changing its strength or by either moving the magnet towards or away from the coil, or moving the coil in or out of the magnetic field.

hence, we can say that the magnitude of the electromagnetic field induced in the circuit is proportional to the rate of change of flux

$$\epsilon \propto \frac{d\varphi_B}{dt}$$

Lenz' Law Formula:

According to Lenz's Law, when an electromagnetic field is generated by a change in magnetic flux, the initial changing magnetic field which produced it.

The formula for Lenz law is shown below:

$$\epsilon = -N\left(\frac{d\phi_B}{dt}\right)$$

Where, ϵ = induced EMF

$d\phi_B$ = change in magnetic field.

N = Numbers of turns in the coil.

Lenz's law Application:

The Application of Lenz's Law include:

When a source of an electromagnetic field is connected across an inductor, a current starts flowing through it, The back electromagnetic field will oppose this increase in current through the inductor. To established the flow of current the external source of the electromagnetic field has to do some work for overcoming this opposition.

1. Lenz's law is used the electromagnetic breaks and induction cooktops.
2. It is also applied to electric generators AC generators.
3. Eddy current dynameters
6. Braking systems on train.
7. Card Readers.
8. Microphones.

Ans to the Qus NO: 02 (b)

Answer: The magnetude of electric field Strength E such that an electron placed in it would experience an electrical force equal to its weight is given by

$$eF = mg$$

$$1.6\times10^{-19}\times E = 9.11\times10^{-31}\times10$$

Magnitude of electric field which balances the weight of the electron,

$$E = \frac{9.11\times10^{-30}}{1.6\times10^{-19}} = 5.693\times10^{-12}\ N/C$$

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