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COURSE : Physics-2

course code : PHY127

Semester : Spring-2023

①

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

$$\Phi = \frac{Q}{\varepsilon_0}$$

enclosed charge C

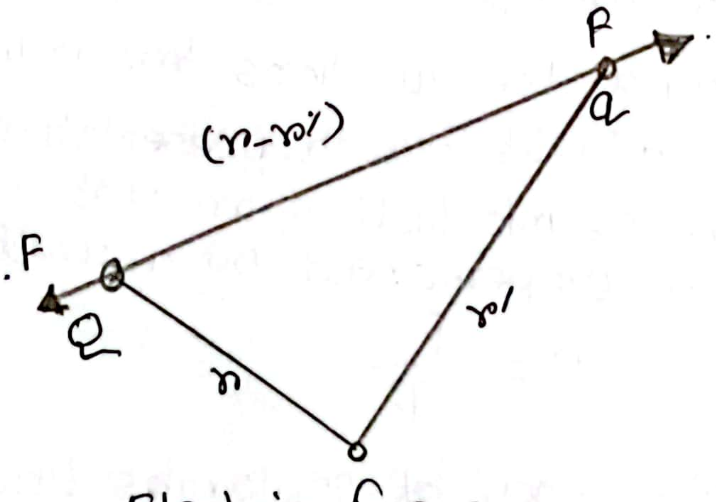
permiltirdty of free space (8.85×10^{-12})

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 student's of electromagnetism. It describes the force between two point electric charge



Electric force.

It turns out that it's equivalent to Gauss's law. Coulomb'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 sign, the force is attractive and if the charges are of same sign, the force is repulsive.

Mathmatically, Coulomb's law is written as

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

where F is the force between the two charges q and Q, $|r-r'|$ is the distance between the charges and $\hat{\underline{r}}$ 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 [Griggs]. We can define the electric field of an arbitrary charge Q, as the force experienced 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

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

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 charges is equal to the sum of the electric fields due to each individual charge.

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

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

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

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 valume ΔV, Applying this definition to the electric field of a point charge q at the origin gives

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

F

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

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

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

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 of

01

Ans to the Qus NO: 01 (c)

Ans: Gauss Law in Dielectrics :

Consider a parallel-plate capacitor with plate area A and having vacuum between its plates, Let +q and -q be the changes on the plates and E0 the uniform electric field between the plates. and E0 the Uniform electric field. Let PQRS be a Gaussain surface.

by Gauss's law, $\oint E_0 . ds = q/\varepsilon_0$

$E_0 \parallel ds$ and constant over the Gruass's law surface.

$\oint E_0 \cdot ds = q E_0 ds = E_0 A$

$\therefore E_0 A = q/\varepsilon_0$ or $E_0 = q/\varepsilon_0 A$ ---- (1)

Suppose a material of dielectric constant k is introduced in the intervening space between the two plates. The dielectric Slab gets polarized. A negative changed -q and +q on the dielectric are called the "induced charges or "bound charges" while the charges +q and -q on the capacitor plates are called free charges. These induced charges produce their own field which oppose the external Field E_0. Let E be the resultant field within the dielectric. The net charge within the Gaussian surface is $q-q'$,

$\therefore$ by Gauss's law, $\oint E . ds = q-q'/\varepsilon_0$ ---- (2)

or $EA = q-q'/\varepsilon_0$ or $E = q-q'/\varepsilon_0 A$ ------ (3)

NOW; $E_0/E = k$, where k is dieelectric constant.

Eq (1) becomes, $E = q/k\varepsilon_0 A$

inserting this is Eq (3) $q/\varepsilon_0 A = q-q'/\varepsilon_0 A$

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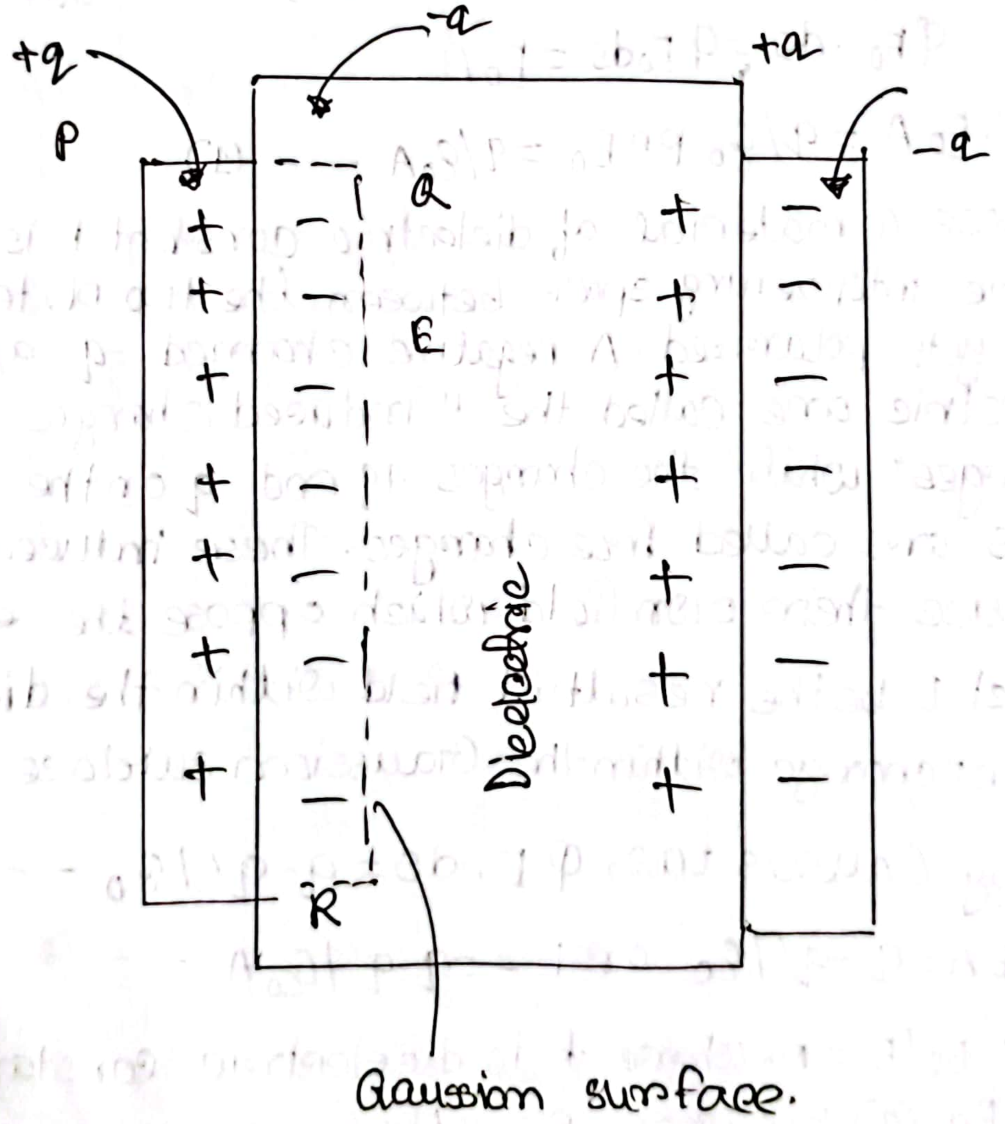
or $q - q' = q/K$

Substituting this value of $q-q'$ in Eq - (2)

$$\oint E.dS = q/K\varepsilon_0$$

$$\therefore \oint K E.dS = q/\varepsilon_0 \quad ---- (4)$$

It is the Gauss's Law in the presence of a dielectri[c]. here we see that the flux integral contains a factor K. the effect of the induce surface charge is ignore[d] by taking into accounting K, the dielectric constant. For dielectric constant, ε_r is used instead of K,



03

Ans to the QUS NO (02)(a)

(a) Answer: Ohm's Law:

Ohm's law, description of the relationship between current, voltage, resistance. The amount of steady current through a large number of materials is directly proportional to the potential difference, or voltage, across the materials, thus, if the voltage across the materials. V (in units of volts) between two ends of a wire made from one of these materials is triped, the current I (amperes) also triples, and the quotient V/I remains constant. The quotient V/I remains constant. The quotient V/I for a given piece of material is called its resistance R. measured in units named ohms. The resistance of materials for which ohm's Law is vaild does not change over enormous ranges of Voltage and current. Ohm's Low may be expressed mathmatically as V/I =R. That the resistance, or the ratior of voltage to current, for all or part of an electric circuit at a fixed temperature is generally constant had been established by 1827 as a result of the investigation of the german physicist Georg Simon ohm.

Alternate statements of ohm's law are that the current I in a conductor equals the potential difference V across the conductor divided by the resistance of the conductor, or simply $I = V/R$, and that the potential difference V across the conductor, divided by the resistance of the conductor, or and its resistance $V = IR$, in a circuit in which $I = E/R$.

Bio- savart Law:

we know that electromagnetism is an important branch of physics that deals with electromagnetic force. It typically deals with magnetic force and electric current. Let us know about the law that relates magnetic fields to the electric current - Bio-Savart Law.

Bio-Savart Law is an equation that gives the magnetic field produced due to a current carrying segment. The segment is taken as a vector quatity known as the current element.

Formula:

consider a current carrying wire "i" in a specific direction as shown in the above figure. Take a small element of the wire of length ds. The direction of this element is along that of the current so that it forms a vector ids.

To know the magnetic field produced at a point due to this small element is along that of the current so that it forms a vector ids.

To know the magnetic field produced at a point due to this small element, one can apply Biot-Savart's Law. Let the position vector of the point in questions drawn,

$$|dB| = \left(\frac{\mu_0}{4\pi}\right)\left(\frac{ids \sin\theta}{r^2}\right)$$

Ans to the Ques NO: 02(b)

Ans: Ampere's law:

According to Ampere's law, magnetic fields are related to the electric current produced in them. The law specifies the magnetic field that is associated with a given current or vice-versa, provided that the electric field doesn't change with time.

Ampere's Law can be stated as:

"The magnetic field created by an electric current is proportional to the size of that electric current with a constant of proportionality equal to the permeability of free space."

Applications of Ampere's Law:

→ Determine the magnetic induction due to a long current carrying wire.
→ Determine the magnetic field inside a toroid.
→ Determine the magnetic field created by a long-current carrying conducting cylinder.
→ Determine the magnetic field inside the conductor.
→ Find forces between currents.

$$\Rightarrow \quad L = 2\pi r H = I_{enc}$$

$$\Rightarrow \quad H = \frac{I_{enc}}{2\pi r}$$

Faraday's law:

The phenomenon called electromagnetic induction was first noticed and investigated by Faraday, and the law of induction is its quantitative expression. Faraday discovered on the basis of experimental observations. The Faraday's dis made to grow and collapse by closing and opening the electric circuit of which it was a part. an electric current could be detected in a separate conductor nearby. Moving a permanent magnet into and out of a coil of wire also induced a current in the wire while the magnet was in motion. Moving a conductor near a stationary permanent magnet caused near a stationary permanent magnet caused a current to flow in the wire, too, as long as it was moving. Faraday visualized a magnetic field as composed of many lines of induction, along which a small magnetic compass would point. The aggregate of the lines intersecting a given area is called the magnetic flux. Some years Later. The fundamental effect of changing magnetic flux was the production of an electric field. not only in a conductor (where it could drive an electric charge) but also in space even in the absence of electric charges. The relationship, known as Faraday's Law.

$$emf = \frac{-d\varphi}{dt}$$

Ans to the Qus NO: 03(a)

Ans: Quantum theory:

Quantum theory is the theoretical basis of modern physics that explains on the atoto atomic and subatomic level.

The nature and behavior of matter and energy at that level is sometimes referred to as quantum physics and quantum mechanics. Organizations in several countries have devoted significant resources to the development of quantum theory to drastically improve computing capabilities beyond what is possible using today's classical computers.

Although scientists throughout the past century have balked at the implications of quantum theory - planck and Einstein among them. the theory's principles have repeatedly been supported by experimentation, even when the scientists were trying to disprove them. Quantum theory and Einstein's theory of relativity form the basis for modern physics. The principles of quantum physics are being applied in an increasing number of areas, including quantum optics, quantum chemistry, quantum computing and quantum cryptography.

Bohr's model :

The bohr model of the atom was proposed by Neil Bohr in 1915. It come into existence with the modification of Rutherford's model of an atom. Rutherford's model introduced in the nuclear model of an atom, in which he explanied that a nucleus is sourrounded by negatively charged electrons.

Bohr theory modified the atomic structure model by explaining that electrons move in fixed orbital (shell) and not anywhere in between and he also explained that each orbit (shell) has a fixed energy. Rutherford explained the nuclues of an atom and Bohr modified that model into electrons and their energy levels.

Bohr's model consists of a small nucleus (positively charged) surrounded by negative electrons moving around the nucleus in orbits. Bohr found that an electron located away from the nucleus has more energy. and the electron which is closer to nucleus has less energy.

(07)

Ans to the Qus NO: (03)(b)

Ans: To determine the magnitude of the electric field, E, at any radius r, we need additional information such as the charge distribution or the total charge enclosed within the radius r, without this information we cannot directly calculate the electric field.

The given value, dB/dt = 0·12 ·Weber/M^2 sec, seems to represent the magnetic field, not the electric field. If you have information about the magnetic field, it won't be directly helpful in determining the electric field.

If you can provide more details about the charge distribution or the total charge enclosed within the radius r, I can assist you in calculating the electric field at that radius

Ans to the Qus NO: 04

Ans: To calculate the electric field strength in a dielectric material between two plates, we need to know the applied voltage and the dimensions of the system. Let's assume you have a parallel plate capacitor with plate area A and plate separation d, and a voltage v is applied across the plates.

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The electric field strength (E) in the dieleetric can be calculated using the formula:

$$E = V/d$$

where V is the applied voltage and d is the distance between the plates.

To calculate the potential difference (V) between the plates, we can use the formula.

$$V = Ed$$

Where E is the electric field strength and d is the distance between the plates.