IQRA NATIONAL UNIVERSITY

Electro Magnetic Field

Mid Term Summer Paper 2020

Name: Kaleem Ullah

ID: 13170

Submitted to: Dr.Rafiq Mansoor

ID # 13170

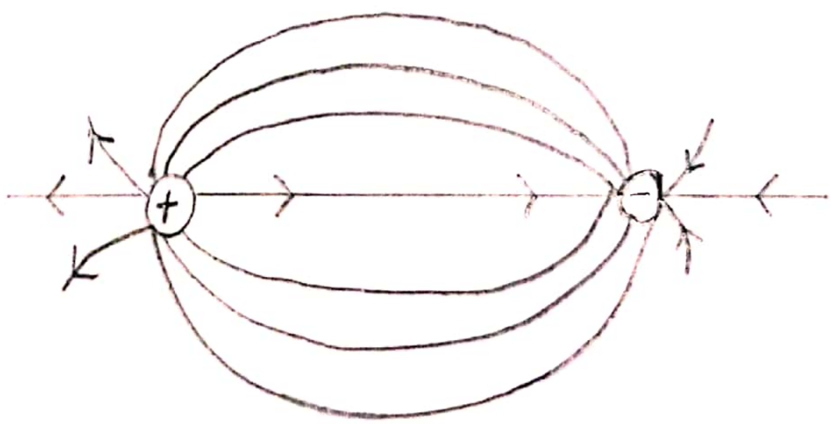
=> Question No (1)

=> Part (A)

What is the difference between electric field and magnetic field?

Answer :- Electric Field

it is defined as the electric force per unit charge The direction of the field is taken to be the direction of the force it would exert on a positive test charge The electric field is radially outward from a positive charge and radially in toward a negative point charge.

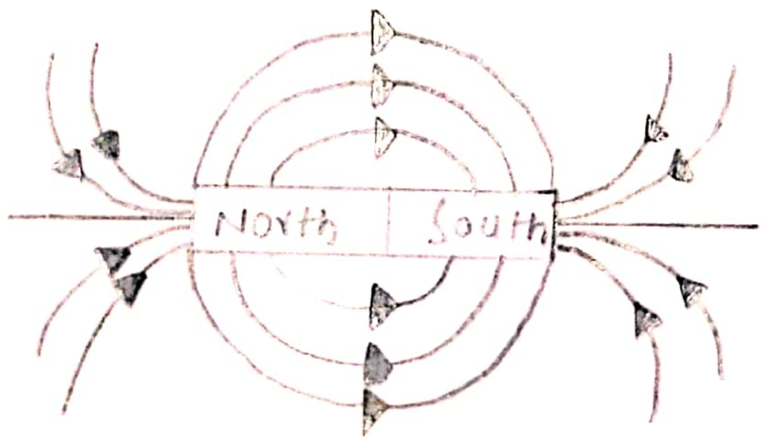


Diagram

ID#13170

⇒ Magnetic Field

A magnetic field is a vector field that describes the magnetic influence on an electric charge of other moving charges or magnalized materials The effects of magnetic fields are commonly see in permanent magnets which pull on magnetic material such as iron and attract or repel other magnets creating a torque.



Diagram

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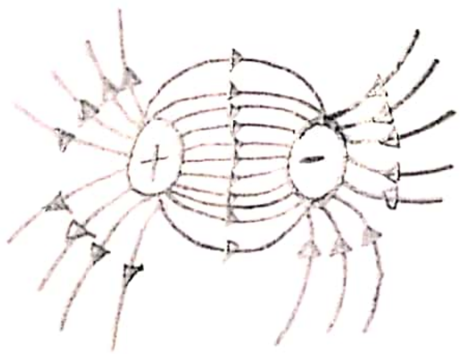
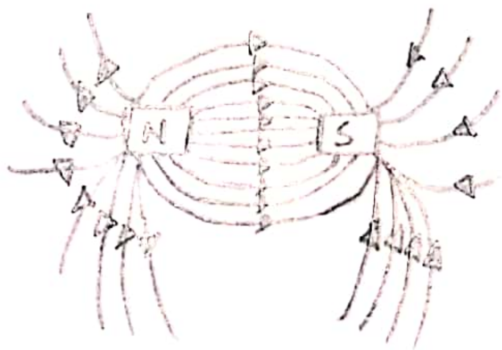
Difference between Electric Field and Magnetic Field

The magnetic field is an exerted area around the magnetic force it is obtained by moving electric charges The direction of the magneti is indicated by lines while the electric fields are genrated around the partical which obtain electric charge during this process positive charges are drawn while negative charges are repelled.

Electric Field Vs Magnetic Field





⇒ Question No (1)

⇒ Part (B)

Given $A = 2a_x - 3a_y + a_z$ and $B = -4a_x - 2a_y + 5a_z$

Find $A * B$

Solution:- $A \times B = (A_y B_z - A_z B_y) a_x + (A_z B_x - A_x B_z) a_y + (A_x B_y - A_y B_x) a_z$

⇒ Put values

$$A \times B = ((-3)(5) - (1)(-2)) a_x + ((1)(-4) - (2)(5)) a_y + ((2)(-2) - (-3)(-4)) a_z$$

$$A \times B = (-15 + 2) a_x + (-4 - 10) a_y + (-4 - 12) a_z$$

$$\boxed{A \times B = -13 a_x - 14 a_y - 16 a_z}$$

Answer.

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ID# 13170

=> Question No (2)

=> Explain the three coordinates in detail with vector representation?

Answer:- vector

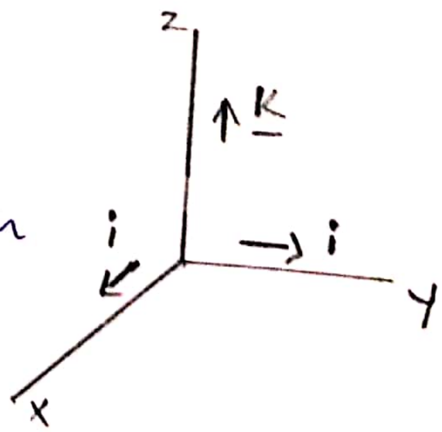
A quantity having direction as well as magnitude especially as determin-ing the position of one point in space relative to another. is called vector.

=> Representation of vector

A vector is usally represented by arrows with their length representing the magnitude and their direction →.

=> unit vector

A vector of unit length



⇒ **Base vectors for a rectangular**

⇒ **Coordinate System**

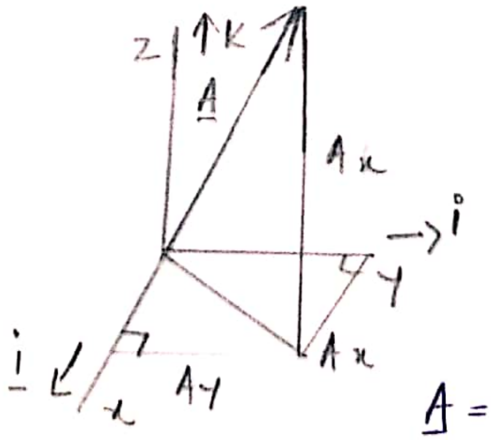
A set of three mutually orthogonal unit vectors

⇒ **Right handed System**

A coordinate system represented by base vectors which follow the right hand rule.

⇒ **Rectangular Component of a vector**

The projections of vector $\underline{A}$ along the x, y, and z directions are A_x, A_y, and A_z respectively.



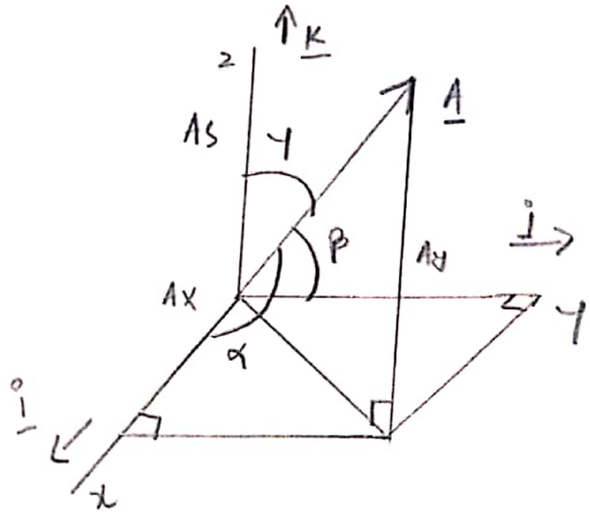
$\underline{A} = A_x \underline{i} + A_y \underline{j} + A_z \underline{k}$

⇒ Magnitude of a vector

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

⇒ Direction of Cosines

$$\cos(a), \cos(b), \cos(g)$$



$$\cos(\alpha) \frac{A_x}{A}, \cos(B) = \frac{A_y}{A}, \cos(\gamma) = \frac{A_z}{A},$$

$$\cos^2(\alpha) + \cos^2(B) + \cos^2(\gamma) = 1$$

⇒ unit vector along a vector

The unit vector $\underline{u_A}$ along the vector $\underline{A}$ is obtained from

$$\Rightarrow \underline{u_A} = \frac{\underline{A}}{A} = \frac{A_x}{A}\underline{i} + \frac{A_y}{A}\underline{j} + \frac{A_z}{A}\underline{k} = \cos(\alpha)\underline{i} + \cos(B)\underline{j} + \cos(\gamma)\underline{k}$$

$$\Rightarrow \underline{A} = A\underline{u_A} = A\cos(\alpha)\underline{i} + A\cos(B)\underline{j} + A\cos(\gamma)\underline{k}$$

⇒ Addition of vectors

The resultant vector $\underline{F}_R$ obtained from the addition of vectors $\underline{F}_1, \underline{F}_2$ and ...... $\underline{F}_n$ is given by

$$\underline{F}_R = \sum \underline{F} = \sum F_x \underline{i} + \sum F_y \underline{j} + \sum F_z \underline{k}$$

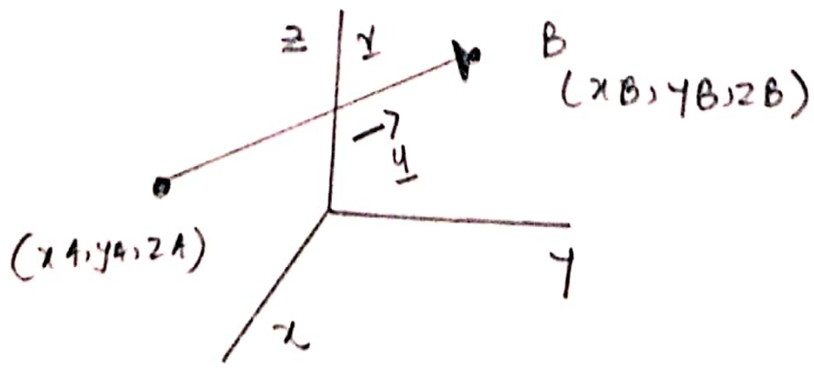
⇒ Coordinates of points in Space

The triplet (x, y, z) desribe the coordinates point

⇒ The vector connecting two points.

The vector connecting point A to poin B is given by.

$$\underline{r} = (x_B = x_A)\,\underline{i} + (y_B - y_A)\,\underline{j} + (z_B - z_A)\,\underline{k}$$



⇒ A unit vector along the line A-B

A unit vector along the line A-B is obtained from.

$$\underline{u} = \frac{\underline{r}}{r}$$

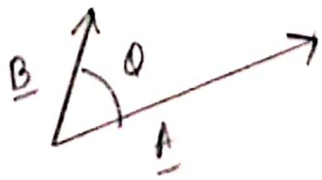
⇒ A vector along A-B

A vector $\underline{F}$ along the line A-B and of magnitude F can be obtained from

$$\underline{F} = F\frac{\underline{r}}{r} = F\underline{u}$$

⇒ The dot product

The dot product of vector $\underline{A}$ and $\underline{B}$ is given by



$$\underline{A} \circ \underline{B} = AB\cos(\theta) = A_x B_x + A_y B_y + A_z B_z.$$

ID# 13170

=> Projection of a vector by using the dot product

The projection of vector $\underline{A}$ along the unit vector $\underline{u}$ is given by.

$$\underline{A} \circ \underline{u} = A \cos(\theta)$$

ID # 1317[illegible]

⇒ Question No (3)

⇒ Part (A)

Explain in detail Electrical field Intensity and electric flux density.

Answer :- Electric field Intensity

The Space around an electric charge in which its influence can be felt is known as the electric field The electric field Intensity at a point is the force by a unit Positive charge placed at that Point

- Electric field Intensity is a vector quantity
- it is denoted by E
- Formula : Electric Field = F/q
- unit of E is NC^{-1} or Vm^{-1}

ID# 13170

=> Due to point charge q the intensity of the electric field at a point d units away from it is given by the expression.

=> Electric Field Intensity $(E) = q / [4\pi\epsilon d^2] \ NC^{-1}$

=> The intensity of the electric field at any point due to a number of charges is equal to the vector some of the sum intensities produced by the separate charges.

=> and a measure of the force exerted by one charged body to another. The electric field intensity (voltmeter) at any location is the force (newtons) that would be experienced by unit test charge (coulombs).

ID# 13170

⇒ Electric Flux density

Electric Flux density is defined as the amount of flux passes through unit surface area in the space imagined at right angle to the direction of electric field the expression of electric field at a point is given

$$E = \frac{Q}{4\pi \varepsilon_0 \varepsilon_r r^2}$$

where Q is the charge of the body by which the field is created R is the distance of the point from the center of the charged body

⇒ As we know, $Q = \Psi$

The above equation can be written as

$$\Rightarrow E = \frac{\psi}{4\pi\epsilon_0\epsilon_r r^2} \Rightarrow \epsilon_0\epsilon_r E = \frac{\psi}{4\pi r^2}$$

This is the expression of flux per unit area since $4\pi r^2$ is the surface area of the imagnary spare of radius r. This is the flux passing through per unit area at a distance r from the center of the charge This is called electric flux density.

⇒ we genrally denoted it with english letter D There fore

$$\Rightarrow D = \epsilon_0 \epsilon_r E$$

From the above expression of D it is clear that electric field Intensity and electric field density are in same phasor.

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ID# 13170

⇒ Question No (3)

⇒ Part (B)

Point charge 5nC and -2nC are located at (2,0,4) and (-3,0,5) respectively

(i) Determine the force on 1nC point charge located at (1,-3,7)

(ii) Find electric field $\vec{E}$ at (1,-3,7)

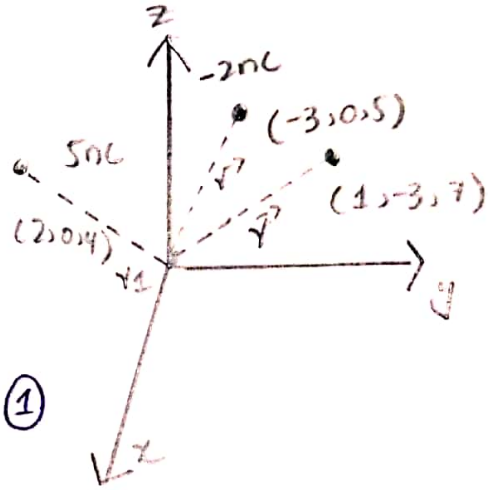
Solution (i)

As $Q_1 = 5nC$, $Q_2 = -2nC$

$$\vec{r} = \vec{a}_x - 3\vec{a}_y + 7\vec{a}_z$$

$$r_1 = 2\vec{a}_x + 4\vec{a}_z$$

$$r_2 = -3\vec{a}_x + 5\vec{a}_z$$



$$\vec{F} = \frac{Q Q_1 (\vec{r} - \vec{r}_1)}{4\pi\varepsilon_0 (\sqrt{\vec{r}-\vec{r}_1})^3} \rightarrow (1)$$

Put values in (1)

$$\vec{F} = \frac{(1\times10^{-9})(5\times10^{-9})}{4\pi\left(\frac{10^{-9}}{36\pi}\right)} \frac{(\vec{a}_x - 3\vec{a}_y + 7\vec{a}_z) - (2\vec{a}_x + 4\vec{a}_z)}{(\sqrt{-\vec{a}_x - 3\vec{a}_y + 3\vec{a}_z})^3}$$

$$+ \frac{(1\times10^{-9})(-2\times10^{-9})}{4\pi\left(\frac{10^{-9}}{36\pi}\right)} \frac{(\vec{a}_x - 3\vec{a}_y + 7\vec{a}_z) - (-3\vec{a}_x + 5\vec{a}_z)}{(\sqrt{4\vec{a}_x - 3\vec{a}_y + 2\vec{a}_z})^3}$$

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$$\Rightarrow \vec{F} = \frac{(45\times10^{-9})(\vec{a}x+3\vec{a}y+3\vec{a}z)}{(19)^{3/2}} - \frac{(18\times10^{-9})(4\vec{a}x-3\vec{a}y+2\vec{a}z)}{(29)^{3/2}}$$

$$\vec{F} = \frac{(-45,-135,135)}{(19)^{3/2}} - \frac{(72,-54,36)}{(29)^{3/2}}$$

$$\vec{F} = (-0.543,-1.630,1.630)-(0.461,-0.346,0.23)\,nN$$

$$\boxed{\vec{F} = -1.004\vec{a}x - 1.284\vec{a}y + 1.4\vec{a}z \; nN}$$

Answer.

$\Rightarrow$ (ii) Electric Field $= \vec{E} = \vec{F}/q$

put the values

$$\vec{E} = \vec{F}/q = \frac{-1.004\vec{a}x - 1.28\vec{a}y + 1.4\vec{a}z \times 10^{-9}}{1\times10^{-9}}$$

$$\boxed{\vec{E} = -1.004\vec{a}x - 1.284\vec{a}y + 1.4\vec{a}z \; V/m}$$

Answer.

Thank You