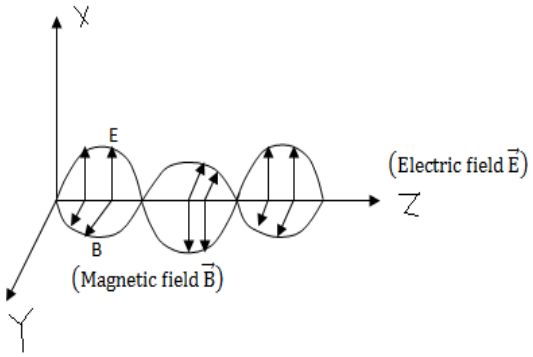
Q13. How does a charge q oscillating at certain frequency produce electromagnetic waves?

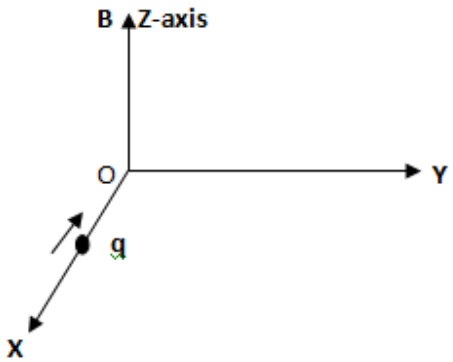
Sketch a schematic diagram depicting electric and magnetic fields for an electromagnetic wave propagating along the Z-direction.

Surrounding an electric charge we have electric field, if the charge oscillates then electric field changes which creates magnetic field also. Hence accelerated charge produces electric and magnetic fields, the electric and magnetic field vectors are mutually perpendicular and direction of propagation of the electromagnetic wave is perpendicular to the plane containing electric and magnetic vector.

Schematic Diagram



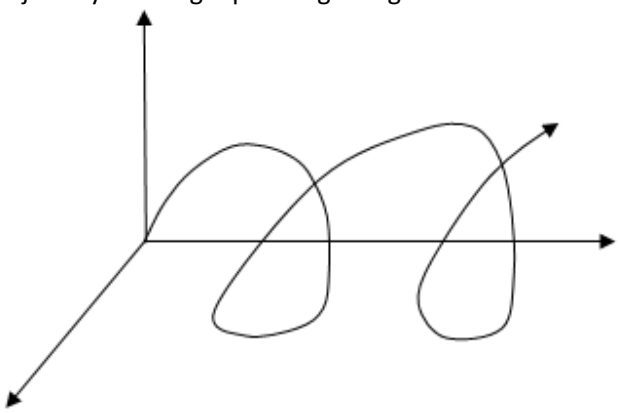
Q14. A charge 'q' moving along the X-axis with a velocity $\vec{v}$ is subjected to a uniform magnetic field B acting along the Z-axis as it crosses the origin O.



Trace its trajectory.

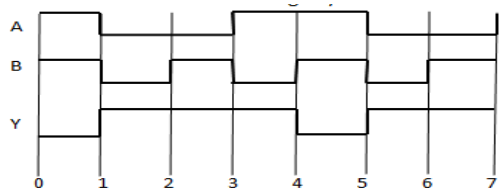
(i) Does the charge regain kinetic energy as it enters the magnetic field? Justify your answer.

(i) The trajectory of charge q moving along x-axis will be **helical.**



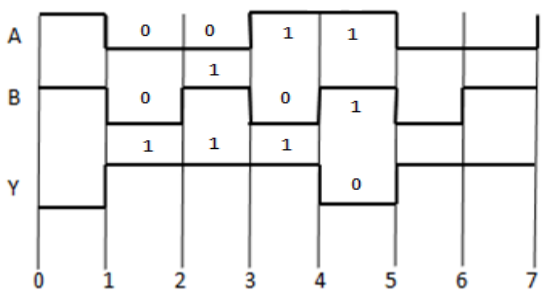
(ii) The speed and kinetic energy of the particle remain constant but the velocity of the charged particle changes its direction.

Q15. The following figure shows the input waveforms (A, B) and the output waveform (Y) of gate. Identify the gate, write its truth table and draw its logic symbol.

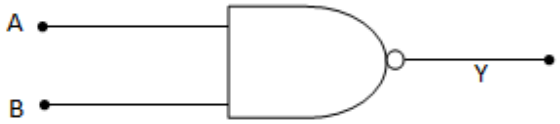


(i) Gate : NAND Gate Truth Table

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

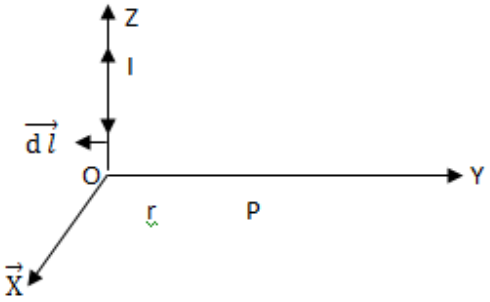


(ii) Logic symbol :



Q16. State Biot-Savart law.

A current flows I flows in a conductor placed perpendicular to the plane of the paper. Indicate the direction of the magnetic field due to a small element $d\vec{l}$ at point P situated at a distance $\vec{r}$ from the element as shown in the figure.



Given

i = current flowing through the element

dl = the length of the element of the conductor

r = AP = the distance of the given point from the element of the conductor

$\hat{r}$ = a unit vector along AP

$\hat{dl}$ = a vector of unit length along the axis of the element in the direction of current

θ = the angle between $\hat{r}$ and $\hat{dl}$

Let $\vec{db}$ = magnetic induction vector at the point P due to the current element

Experimentally it has been found that

$$\left|\vec{db}\right| \propto i, \left|\vec{db}\right| \propto dl, \left|\vec{db}\right| \propto \frac{1}{r^2}, \left|\vec{db}\right| \propto \sin\theta$$

$$db \propto \frac{idl\sin\theta}{r^2}$$

$$db = K' \frac{idl\sin\theta}{r^2} \rightarrow (1)$$

Where K' is a constant of proportionality. The value of K' depends on

(1)Choice of unit

(2)Nature of surrounding medium

In SI system db in tesla, i in ampere, r in meter for free space (air or vacuum)

$K' = 10^{-7} = \frac{\mu_0}{4\pi}$ where $\mu_0 = 4\pi \times 10^{-7}$ henry/meter = permiability in free space

$$\text{db} = \frac{\mu_0}{4\pi}\frac{idl\sin\theta}{r^2} \rightarrow (2)$$

Equation(2) which gives magnitude of magnetic field at P is known as Laplace Formula.

$$\text{db} = \frac{\mu_0}{4\pi}\frac{i}{r^2}\left(\vec{dl} \times \hat{r}\right) \rightarrow (3)$$

Biot-Savart law : According to this law, the magnitude of magnetic field induction at a point due to a current element of length dl , carrying current I, at a distance r from the element is given by

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{\text{I}\, dl \sin\theta}{r^2}$$

Vector form : $\left|d\vec{B}\right| = \frac{\mu_0}{4\pi} \cdot \frac{|dl \times \text{I}|}{r^3}$

The direction of magnetic field $d\vec{B}$ is perpendicular to the plane containing $d\vec{l}$ *and* $\vec{r}$ and is directed **inward.**

Q17. Why are high frequency carrier waves used for transmission?

Ans. Reason

1. High frequency carrier waves travel through space or medium with the speed of light and
2. High frequency carrier waves are not obstructed by earth's atmosphere.

Or, What is meant by term 'modulation'? Draw a block diagram of a simple modulator for obtaining an AM signal.

Modulation is a process of mixing a signal with a sinusoid to produce a new signal. It is the phenomenon of superimposing the low frequency message signal on a high frequency wave (carrier wave).

There are 3 basic types of modulation: Amplitude modulation, Frequency modulation, and Phase modulation.

In Amplitude modulation the amplitude of the carrier signal is modulated (changed) in proportion to the message signal while the frequency and phase are kept constant.

In frequency modulation the frequency of the carrier signal is modulated (changed) in proportion to the message signal while the amplitude and phase are kept constant.

In phase modulation the phase of the carrier signal is varied accordance to the low frequency of the message signal is known as phase modulation.

Block diagram of simple modulator: