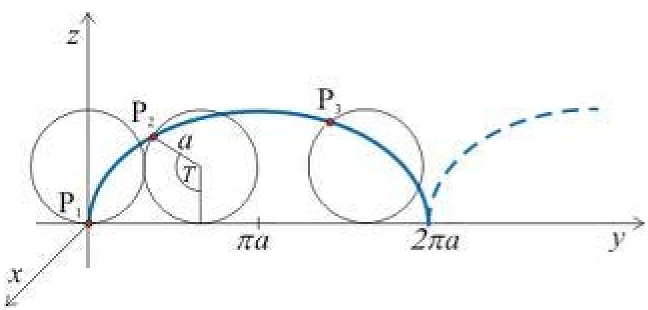
MOTION OF PARTICAL SOME ANGLE WITH MAGNETIC FIELD

Electron is moving with an angle ϕ with magnetic field (where $0 < \phi < 90^0$)

The electron velocity makes an angle ϕ with magnetic filed intensity 'B' (which is not perpendicular to magnetic field the charged particle enters the uniform magnetic field with the initial velocity V_0. The velocity can be resolved into two components.



$v\sin\phi \rightarrow$ velocity component perpendicular to magnetic field intensity (B) $\rightarrow$ circular motion

$v\cos\phi \rightarrow$ velocity component along B $\rightarrow$ circular motion.

These two velocity components makes the particle to move simultaneously in two directions. The vel. component parallel to magnetic field intensity 'B' makes the electron to move linearly (i.e., $v\cos\phi$ component) i.e., along direction of 'B' (x-axis) with constant speed. The velocity component perpendicular to 'B' makes the electron to move in circular path with constant speed.

Radius of circular path $R = \frac{mv}{eB}$

But $V = v\sin\phi$

$$R = \frac{mv\sin\phi}{eB}$$

$$T = \frac{2\pi m}{eB}$$

The net effect due to concurrent motion electron takes the helical path. The pitch of the helix is defined as the distance covered in one revolution along 'B' direction

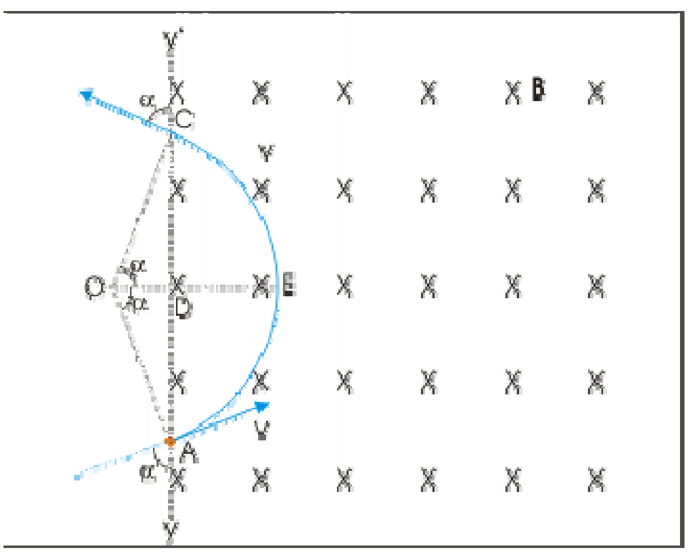
Which is given by

Pitch, $P = UT$

But $V = v\cos\phi$

$\therefore\ p = Tv\cos\phi$

Magnetic deflection in a cathode ray tube:



Here the magnetic field is perpendicular to direction of electron beam i.e., it directs towards the reader.

$\therefore$ The electron beam is deflected upwards. The electron moves in a straight line to point '0' from cathode with initial velocity v_0. Now the force acts on the electron and the resultant direction is $\perp' r$ to both 'B' and 'v' is so resultant path is circular one. Path taken by the electron with in this uniform magnetic field is an arc of circle with radius 'R'. The path OM is an arc of the circle whose centre is at $'\theta'$ (speed of particle remains constant)

$v = v_0 = \sqrt{\frac{2eVa}{m}} =$ velocity with which it enters the magnetic field.

$\tan\phi \approx \frac{length\ of\ \ arc\ OM}{Radius\ of\ \ circle\ R}$ (provided assume small arc (small ϕ), then arc OM appears like a st. line then ΔQOM)

$$\approx \frac{1}{R}$$

Smaller values ϕ, $\tan\phi \approx \frac{l}{R}$

$$\phi \approx \frac{l}{R} \qquad - \qquad (2)$$

Where R is radius of circle $= \frac{mdv}{dB}$ $\qquad - \qquad (3)$

The straight line MP' which is projected back wards and it intersects x-axis at point '0' which is called a virtual cathode.

But in $\Delta O'P'P$

$$\tan\phi = \frac{D}{L}$$

for small ϕ, $\tan\phi \approx \phi = \frac{D}{L}$

$$D \approx L\phi$$

$$\phi \approx \frac{l}{R}$$

$$\therefore D = L\phi = \frac{Ll}{R}$$

But $R = \frac{mv}{eB}$ $\quad$ *from* (3)

$$\Rightarrow D = \frac{LleB}{mv} \qquad - \qquad (4)$$

But $v = v_0 = \sqrt{\frac{2eV_a}{m}}$ $\quad$ from (1)

$$\Rightarrow d = \frac{LleB}{m\sqrt{\frac{2eV_a}{m}}}$$

$$LlB\sqrt{\frac{e}{2V_a m}}$$

Magnetic Deflection sensitivity :

It is defined as the ratio of deflection to the unit magnetic field intensity

$$S_m = \frac{D}{B}$$

$$= \frac{1}{B}\left[LlB\sqrt{\frac{e}{2V_a m}}\right]$$

$$= \left[Ll\sqrt{\frac{e}{2V_a m}}\right]$$

Units for deflection sensitivity $= \frac{mt}{wb/m^2} = \frac{m^3}{wb}$

The magnetic deflection sensitivity is inversely proportional to square root of anode potential $'V_a'$ where as electro static deflection sensitivity is inverely proportional to $'V_a'$ static deflection sensitivity is expressed in terms of $'e/m'$ where as electro static D.S. doesn’t expressed in $'e/m'$.