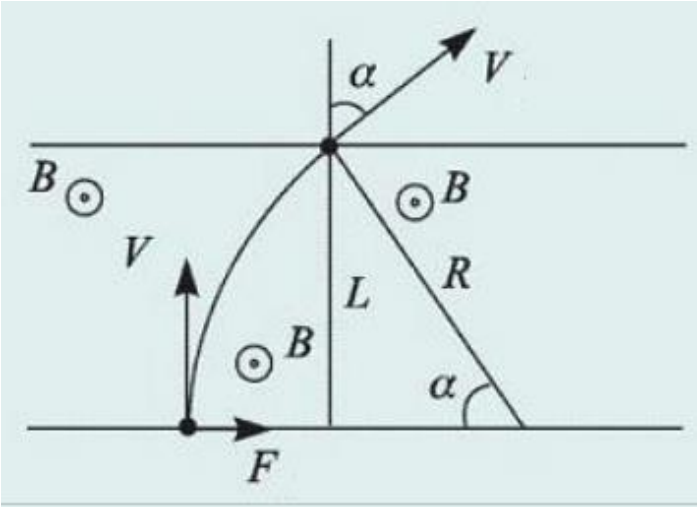
Answer on Question#40683 – Physics – Electromagnetism

A BEAM OF PROTON PASSES THRU A REGION OF UNIFORM MAGNETIC FIELD = 0.01 T.IT CROSSES A SCREEN 10 cm WIDE . IN ORDER TO PREVENT THE BEAM FROM CROSSING THE SCREEN , BEAM IS ROTATED BY 30o. WHAT IS THE MAX. SPEED OF THE PROTONS IN THE BEAM ?

1.1.11 * 10^6 m/s
2. 1.11 * 10^5 m/s
3. 2.92* 10^6 m/s
4. 2.92 * 10^5 m/s

Solution:

$\mathrm{B} = 0.01\ \mathrm{T} - \text{induction of the magnetic field;}$
$\mathrm{L} = 0.1\mathrm{m} - \text{ width of the screen;}$
$\alpha = 30^{\mathrm{o}} - \text{angle of rotation;}$



Magnetic force that acts on the each proton in the beam ($\mathrm{q} - \text{charge of the proton}$):

$$\mathrm{F} = \mathrm{qVB} \quad (1)$$

Due to magnetic field protons will move in a circle:

$$\mathrm{F} = \mathrm{m} \cdot \mathrm{a_c} = \mathrm{m} \cdot \frac{\mathrm{V}^2}{\mathrm{R}} \quad (2)$$

$$(1)\mathrm{in}(2):$$

$$\mathrm{m} \cdot \frac{\mathrm{V}^2}{\mathrm{R}} = \mathrm{qVB}$$

$$\mathrm{R} = \frac{\mathrm{mV}}{\mathrm{qB}} \quad (3)$$

From the right triangle:

$$\sin\alpha = \frac{\mathrm{L}}{\mathrm{R}} \quad (4)$$

$$(3)\mathrm{in}(4):$$

$$\sin\alpha = \frac{L}{\frac{mV}{qB}} = \frac{LqB}{mV}$$

$$V = \frac{LqB}{m \cdot \sin\alpha} = \frac{0.1m \cdot 1.6 \times 10^{-19}C \cdot 0.01T}{1.67 \times 10^{-27}kg \cdot \sin 30°} = 191.6 \times 10^3 \frac{m}{s}$$

Answer: maximum speed of the protons in the beam is equal to $191.6 \times 10^3 \frac{m}{s}$