Answer on Question#61354 – Physics – Electromagnetism

13) A proton is accelerated through a potential difference of 100V and the enters a region in which it is moving perpendicular to a magnetic field of flux density 0.20T. Find the radius of the circular path in which it will travel.
a) 0.9km
b) 0.7km
c)0.3km
d)0.5km
Solution. According to the law of conservation of energy, the electric field is equal to the kinetic energy of the proton.
$A = qV$ (work), where $q = 1.6 \cdot 10^{-19} C$ (the charge of the proton), $V = 100V$ (voltage).
$E = \frac{mv^2}{2}$ (kinetic energy), where $m = 1.67 \cdot 10^{-27} kg$ (mass proton), v – speed proton.
Hence
$\frac{mv^2}{2} = qV \rightarrow v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2 \cdot 1.6 \cdot 10^{-19} \cdot 100}{1.67 \cdot 10^{-27}}} \approx 138426 \frac{m}{s}$.
The relationship between the force on the moving particle, the velocity of the particle through the magnetic field, the strength of that magnetic field and the force on the particle, and the angle between the directions of the particle and magnetic field is:
$F = qvBsin\alpha$, where $B = 0.20T$ (magnetic field), α – angle between magnetic field and velocity (in our case $\alpha = 90^0$). $F = qvB$. The Lorentz force acts as the centripetal force, which can be found by the formula $F = \frac{mv^2}{R}$, R – radius (in our case radius of the circular path).
Therefore $qvB = \frac{mv^2}{R} \rightarrow R = \frac{mv^2}{qvB} = \frac{mv}{qB}$

$$R = \frac{1.67 \cdot 10^{-27} \cdot 138426}{1.6 \cdot 10^{-19} \cdot 0.2} \approx 0.007m$$

Answer. b) 0.7km ($R = 0.007m$)

14) An electron enters a uniform magnetic field 0.20T at an angle of 30o the field. Determine the pitch of the helical path assuming its speed is 3×107 m/s
a) 90.6m
b) 37.8m
c) 56.1m
d) 46.5m
Solution. Find components of velocity parallel and perpendicular to the magnetic field
$v_{\parallel} = v \cos 30^0 = 1.5\sqrt{3} \cdot 10^7 \frac{m}{s}$
$v_{\perp} = v \sin 30^0 = 1.5 \cdot 10^7 \frac{m}{s}$
Electron will move in a helical path. Using the result of the previous problem $R = \frac{mv_{\perp}}{qB}$ (radius helical path). Find the period of motion in a circle

$$T = \frac{2\pi R}{v_{\perp}} = \frac{2\pi m v_{\perp}}{qBv_{\perp}} = \frac{2\pi m}{qB},$$

where $q = 1.6 \cdot 10^{-19} C$ (the magnitude charge of the electron), $B = 0.20T$ (magnetic field), $m = 9.1 \cdot 10^{-31} kg$. Hence
$T = \frac{2\pi \cdot 9.1 \cdot 10^{-31}}{1.6 \cdot 10^{-19} \cdot 0.2} \approx 1.787 \cdot 10^{-10} s.$
Therefore the pitch of the helical path equal to $p = v_{\parallel} T$.

$p = 1.5\sqrt{3} \cdot 10^{7} \cdot 1.787 \cdot 10^{-10} = 4.64 \cdot 10^{-3} m$

Answer. d) 46.5m ($p = 4.64 \cdot 10^{-3} m$).