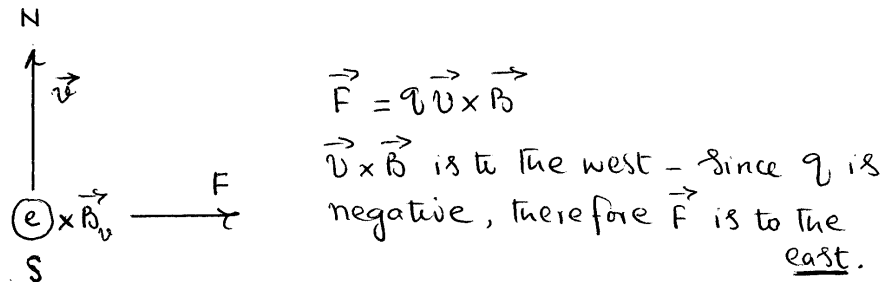


**KING FHAD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF PHYSICS**

**PHYSICS 102 (992)
SOLUTIONS (CHAPTER 29)**

Q.1 Each of the electrons in the beam of a television tube has a kinetic energy of 12.0 keV. The tube is oriented so that the electrons move horizontally from geomagnetic south to geomagnetic north. The vertical component of Earth's magnetic field points down and has a magnitude of 55.0 μT . (a) In what direction will the beam deflect? (b) What is the acceleration of a single electron due to the magnetic field? (c) How far will the beam deflect in moving 20.0 cm through the television tube?



(a) To the east from the above figure.

$$(b) \quad \frac{1}{2}mv^2 = 12 \times 10^3 \text{ eV} \times \frac{1.6 \times 10^{-19} \text{ J}}{\text{eV}} = 1.92 \times 10^{-15} \text{ J}$$

$$v = \sqrt{\frac{2(1.92 \times 10^{-15})}{9.11 \times 10^{-31}}} = 6.50 \times 10^7 \text{ m/s}$$

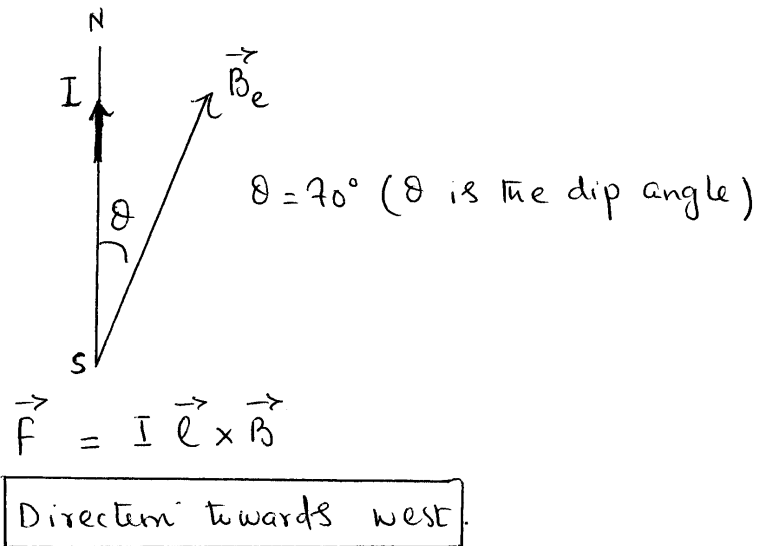
$$ma = \frac{mv^2}{r^2} = qvB \Rightarrow a = \frac{evB}{m}$$

$$a = \frac{(1.6 \times 10^{-19})(6.50 \times 10^7)(55 \times 10^{-6})}{9.11 \times 10^{-31}} = \boxed{6.29 \times 10^{14} \text{ m/s}^2}$$

$$(c) \quad t = \frac{20 \times 10^{-2}}{6.50 \times 10^7} = 3.08 \times 10^{-9} \text{ s}$$

$$y = \frac{1}{2}at^2 = \frac{1}{2}(6.29 \times 10^{14})(3.08 \times 10^{-9})^2 = \boxed{0.00298 \text{ m} = 2.98 \text{ mm}}$$

Q.2 A horizontal conductor in a power line carries a current of 5000 A from south to north. Earth's magnetic field ($60.0 \mu\text{T}$) is directed toward the north and is inclined downward at 70° to the horizontal. Find the magnitude and direction of the magnetic force on 100 m of the conductor due Earth's field.



magnitude $\Rightarrow F = (5000)(100)(60 \times 10^{-6}) \sin 70 = 28.2 \text{ N.}$

Q.3 A physicist is designing a cyclotron to accelerate proton to one-tenth the speed of light. The magnet used will produce a field 1.4 T. Calculate (a) the radius of the cyclotron and (b) the corresponding oscillator frequency. Relativity considerations are not significant.

$$v = \frac{1}{10} (3 \times 10^8 \text{ m/s}) = 3.0 \times 10^7 \text{ m/s}$$

$$B = 1.4 \text{ T}$$

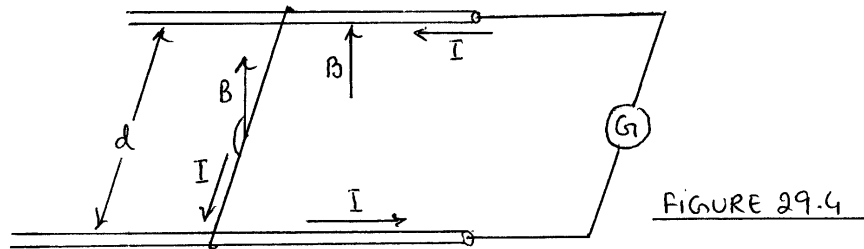
$$a) \quad qvB = m \frac{v^2}{R}, \quad R = \frac{mv}{qB} = \frac{(1.67 \times 10^{-27}) (3 \times 10^7)}{(1.6 \times 10^{-19}) (1.4)}$$

$$R = 0.223 \text{ m or } 22.3 \text{ cm.}$$

$$b) \quad \omega = \frac{v}{R} = \frac{qB}{m}$$

$$f = \frac{\omega}{2\pi} = \frac{qB}{2\pi m} = \frac{(1.6 \times 10^{-19}) (1.4)}{2\pi (1.67 \times 10^{-27})} = 2.1 \times 10^7 \text{ Hz}$$

Q.4 A metal wire of mass m slides without friction on two horizontal rails spaced a distance d apart, as in Figure 29.4. The track lies in vertical uniform magnetic field B . There is a constant current i through generator G , along one rail, across the wire, and back down the other rail. Find the speed and direction of the wire's motion as a function of time, assuming it to be stationary at $t = 0$.



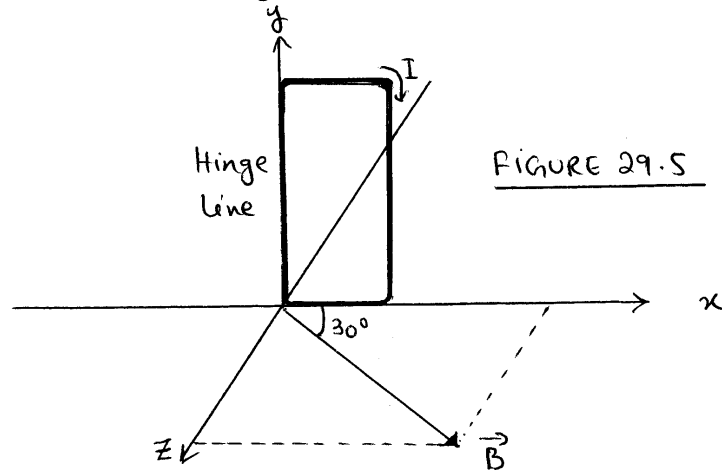
$$\vec{F} = I \vec{\ell} \times \vec{B} = m\vec{a} \quad (\text{The force is to the left})$$

$$a = \frac{I d B}{m}, \quad v = at = \frac{B I d}{m} \cdot t$$

$$v = \frac{B I d t}{m}$$

Direction of motion is to the left.

Q.5 The Figure 29.5, shows a rectangular, 20-turn coil of wire, 10cm by 5.0 cm. It carries a current of 0.10A and is hinged along one long side. It is mounted in the xy-plane, at an angle of 30° to the direction of a uniform magnetic field of 0.50 T. Find the magnitude and direction of the torque acting on the coil about the hinge line.



$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

$$\tau = (20)(0.10)(0.10)(0.05)(0.5) \sin(90+30)$$

$$\tau = +4.33 \text{ N}\cdot\text{m}$$

$$\vec{\tau} = -4.33 \text{ N}\cdot\text{m} \hat{j}$$

Clockwise rotation as viewed from the top.

