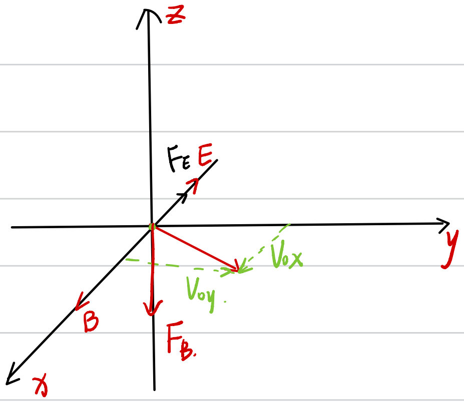
Problem 1



$$V_{0x}' = V_{0x} - \frac{Eqt}{m}. \qquad Bqv = \frac{mv^2}{R} \Rightarrow R = \frac{mv}{Bq}$$

$$V_{oy} = V_{oy} \cos \omega t$$

$$\omega R = v \Rightarrow \omega \cdot \frac{mv}{Bq} = v$$

$$\Rightarrow \omega = \frac{Bq}{m}.$$

then we can get $V_{oy} = V_{oy} \cos \frac{Bq}{m} t$

$$V_{oz} = - V_{oy} \sin \left(\frac{Bq}{m} t\right)$$

$$v = \left(V_{0x} - \frac{Eqt}{m},\ V_{oy} \cos\left(\frac{Bqt}{m}\right),\ -V_{oy} \sin\left(\frac{Bqt}{m}\right) \right)$$

$$r = \left(V_{0x}t - \frac{1}{2}\frac{Eqt^2}{m},\ \frac{mv}{Bq} \cos\left(\frac{Bqt}{m}\right),\ -\frac{mv}{Bq} \sin\left(\frac{Bqt}{m}\right) \right)$$

Problem 2

$\Delta P = \frac{F}{A}$ For the force: $F = BIl\sin\theta$

$A = lw.$ $\quad \Delta P = \frac{IB\sin\theta}{w} = \frac{IB}{w}$

then J is the density of current.

$J \cdot lw = I.$ $\quad \Rightarrow \Delta P = \frac{lw \cdot J \cdot B}{w} = JlB.$

(b) $B: 2.2T.$ $\quad l = 3.5 \times 10^{-2}$ m.

$\Delta P = 1$ atm $\Rightarrow$ 1 atm $= J \cdot 3.5 \times 10^{-2}$ m $\cdot 2.2T$

1 atm $= 101325$ Pa.

$$J = \frac{101325 \text{ Pa}}{3.5 \times 10^{-2} \text{ m} \cdot 2.2T} = 1.32 \times 10^6 \text{ A/m}^2.$$

Problem 3.

Taking micro elements approach to prove.

For any small elements. l: $\Rightarrow F = BI\,dl.$

$$\Sigma F = BI\,dl_1 + BI\,dl_2 + \cdots BI\,dl_n$$

$$F = \int BI\,dl. = \int_a^b BI\,dl = BIl \Big|_a^b$$

$$= BIw.$$

① If the direction of current is pointing right, force direction is ⊗ straight into paper.

② If the direction of current is pointing left force direction is ⊙ straight out of paper.

Problem 4

(b) ① (0.0) to the (0.L). $F = B_y I L$

For a small element. $dF = \frac{B_0 y}{L} I\, dy$ direction: to the right

$$F = \int_0^L \frac{B_0 y I}{L} dy = \frac{\frac{1}{2} B_0 y^2 I}{L}\Big|_0^L = \frac{1}{2} B_0 I L$$

② (0.0) ← (L.0). $F_1 = B_y I L = \frac{1}{2} B_0 I L$. $F_2 = B_z I L = \frac{1}{2} B_0 I L$. $F_{net} = \sqrt{(\frac{1}{2} B_0 I L)^2 \times 2} = \frac{\sqrt{2}}{2} B_0 I L$ $\downarrow -z$

direction: 45° form $-z$ axis to the $+y$ axis.

③ (L.L) → (L.0) $F = B_y I L$

For a small element. $dF = \frac{B_0 y}{L} I\, dy$ direction: to the left.

$$F = \int_0^L \frac{B_0 y I}{L} dy = \frac{\frac{1}{2} B_0 y^2 I}{L}\Big|_0^L = \frac{1}{2} B_0 I L$$

(0.L) ← (L.L). $F_1 = B_y I L = \frac{1}{2} B_0 I L$. $F_2 = B_z I L = \frac{1}{2} B_0 I L$. $F_{net} = \sqrt{(\frac{1}{2} B_0 I L)^2 \times 2} = \frac{\sqrt{2}}{2} B_0 I L$ $\downarrow -z$

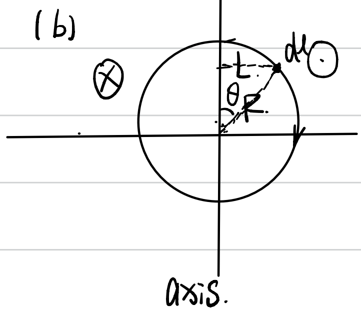
direction: 45° form $+z$ axis to the $-y$ axis.

(c). – net force: 0.

Problem 5.

(a) the net force on the current loop is 0

(b)



$\tau = IAB \sin\varphi$

$A = \pi R^2$ $\varphi = 90°$. $\sin\varphi = 1$

$\Rightarrow \tau = I\pi R^2 B$

Problem 6

(1) $T = \frac{2\pi r}{v} = \frac{2\pi \times 5.3 \times 10^{-11}\, m}{2.2 \times 10^6\, m/s} = 1.5 \times 10^{-6}\, s.$

(2) $I = \frac{dQ}{dt} = \frac{Q}{t} = \frac{1.6 \times 10^{-19}}{1.5 \times 10^{-6}} = 1.1 \times 10^{-3} A$

(3) $\mu = IA = 1.1 \times 10^{-3} A \times \pi \cdot (5.3 \times 10^{-11}\, m)^2 = 9.71 \times 10^{-2} \cdot A \cdot m^2$