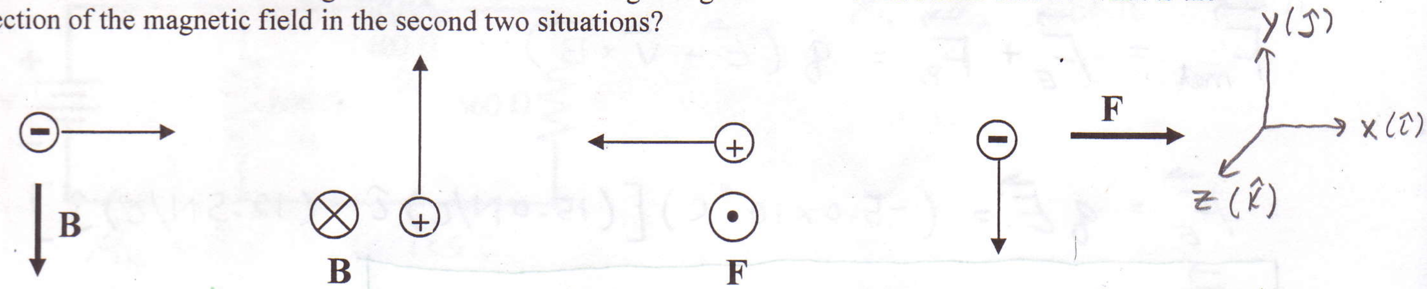
Physics 4B
Fall 2022

Name: Answer Key

Lab (circle one): 8:00 am 11;15 am 2:30 pm

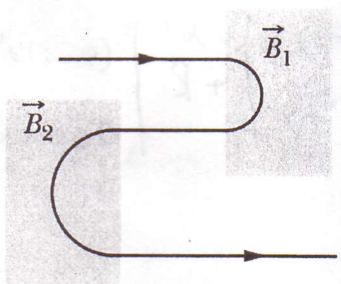
Quiz #7: Magnetic Fields

Problem 1 (2 points)
What is the direction of the magnetic force on the moving charge in first two situations below? What is the direction of the magnetic field in the second two situations?



out of page ($\hat{k}$)	to the left ($-\hat{i}$)	down ($-\hat{j}$)	out of page ($\hat{k}$)

Problem 2 (3 points)
The figure to the right shows the path of an electron that passes through two regions containing uniform magnetic fields of magnitudes B_1 and B_2. Its path in each region is a half-circle. **(a)** Which field is stronger? **(b)** What is the direction of B_1? What is the direction of B_2? **(c)** Is the time spent in region 1 greater than, less than, or the same as the time spent in region 2?



(a) B_1 $\qquad r = mv/qB \rightarrow B = mv/qr$ (smaller r, bigger B)

(b) B_1: into page $\qquad B_2$: out of page

(c) less than $\qquad T = 2\pi m/qB \rightarrow T \propto 1/B$

Problem 3 (5 points)

A charged particle of mass m = 1.3×10^{-6} kg and charge q = -5.0 nC moving with a velocity $\vec{v} = (5.0\times10^6\ \text{m/s})\hat{i} - (6.5\times10^6\ \text{m/s})\hat{k}$ enters a region with both electric and magnetic fields. The electric field is given by $\vec{E} = (15.0\,N/C)\hat{i} - (12.5\,N/C)\hat{j}$ and magnetic field is given by $\vec{B} = (10.6\,\mu\text{T})\hat{j} + (9.5\,\mu\text{T})\hat{k}$. Determine the net force on the particle in unit vector notation.

$$\vec{F}_{net} = \vec{F}_E + \vec{F}_B = q(\vec{E} + \vec{v}\times\vec{B})$$

$$\vec{F}_E = q\vec{E} = (-5.0\times10^{-9}\,C)\left[(15.0\,N/C)\hat{i} - (12.5\,N/C)\hat{j}\right]$$

$$\boxed{\vec{F}_E = (-75\times10^{-9}\,N)\hat{i} + (62.5\times10^{-9}\,N)\hat{j}}$$

$$\vec{F}_B = q\vec{v}\times\vec{B} \qquad \vec{v}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ (5.0\times10^6\,m/s) & 0 & (-6.5\times10^6\,m/s) \\ 0 & (10.6\times10^{-6}\,T) & (9.5\times10^{-6}\,T) \end{vmatrix}$$

$$\vec{v}\times\vec{B} = \hat{i}\begin{vmatrix} 0 & (-6.5\times10^6\,m/s) \\ (10.6\times10^{-6}\,T) & (9.5\times10^{-6}\,T) \end{vmatrix} - \hat{j}\begin{vmatrix} (5.0\times10^6\,m/s) & (-6.5\times10^6\,m/s) \\ 0 & (9.5\times10^{-6}\,T) \end{vmatrix} + \hat{k}\begin{vmatrix} (5.0\times10^6\,m/s) & 0 \\ 0 & (10.6\times10^{-6}\,T) \end{vmatrix}$$

$$\vec{v}\times\vec{B} = (68.9\,Tm/s)\hat{i} - (47.5\,Tm/s)\hat{j} + (53.0\,Tm/s)\hat{k}$$

$$\vec{F}_B = q\vec{v}\times\vec{B} = (-5.0\times10^{-9}\,C)\left[(68.9\,Tm/s)\hat{i} - (47.5\,Tm/s)\hat{j} + (53.0\,Tm/s)\hat{k}\right]$$

$$\boxed{\vec{F}_B = (-345\times10^{-9}\,N)\hat{i} + (238\times10^{-9}\,N)\hat{j} - (265\times10^{-9}\,N)\hat{k}}$$

$$\boxed{\vec{F}_{net} = \vec{F}_E + \vec{F}_B = (-4.2\times10^{-7}\,N)\hat{i} + (3.0\times10^{-7}\,N)\hat{j} - (2.7\times10^{-7}\,N)\hat{k}}$$