

## Phys 202 - A5

1.

a) "perpendicular to"  $\rightarrow \theta_{AB} = 90^\circ$

b)  $\vec{v} = 2.10 \times 10^7 \hat{k}$

c)  $\vec{a} = 1.80 \times 10^{13} \text{ m/s}^2 \hat{i}$

d) "proton" :  $q = 1.602 \times 10^{-19} \text{ C}$   
 $m = 1.672 \times 10^{-27} \text{ kg}$

$$\vec{F} = m \vec{a}$$

e)  $\vec{v} = v \hat{k}$

$$= (1.672 \times 10^{-27})(1.80 \times 10^{13}) \hat{i}$$

$$= 3.006 \times 10^{-14} \hat{i}$$

$$\vec{F} = q \vec{v} \times \vec{B}$$

$$|\vec{F}| = |q| |\vec{v}| |\vec{B}| \sin \theta$$

$$3.006 \times 10^{-14} = (1.609 \times 10^{-19}) (2.10 \times 10^7) |\vec{B}| (1)$$

$$|\vec{B}| = 0.00895 \boxed{?} \text{ Tesla}$$

Unit

$$[F] = [q] [v] [B] \sin \theta$$

$$[B] = \frac{[F]}{[q][v]} = \frac{N}{C \cdot m/s} = \frac{kg \cdot m/s^2}{C \cdot m/s}$$

$$= \frac{kg}{C \cdot s} \\ \equiv 1 \text{ Tesla} \\ = 1 T$$

Direction:

$$\vec{F} = q \vec{v} \times \vec{B}$$

$$\vec{F} = q v B \sin \theta \hat{n}$$

$$\vec{F} = q \vec{v} \times \vec{B}$$

↑  
i

↑  
 $\hat{k}$

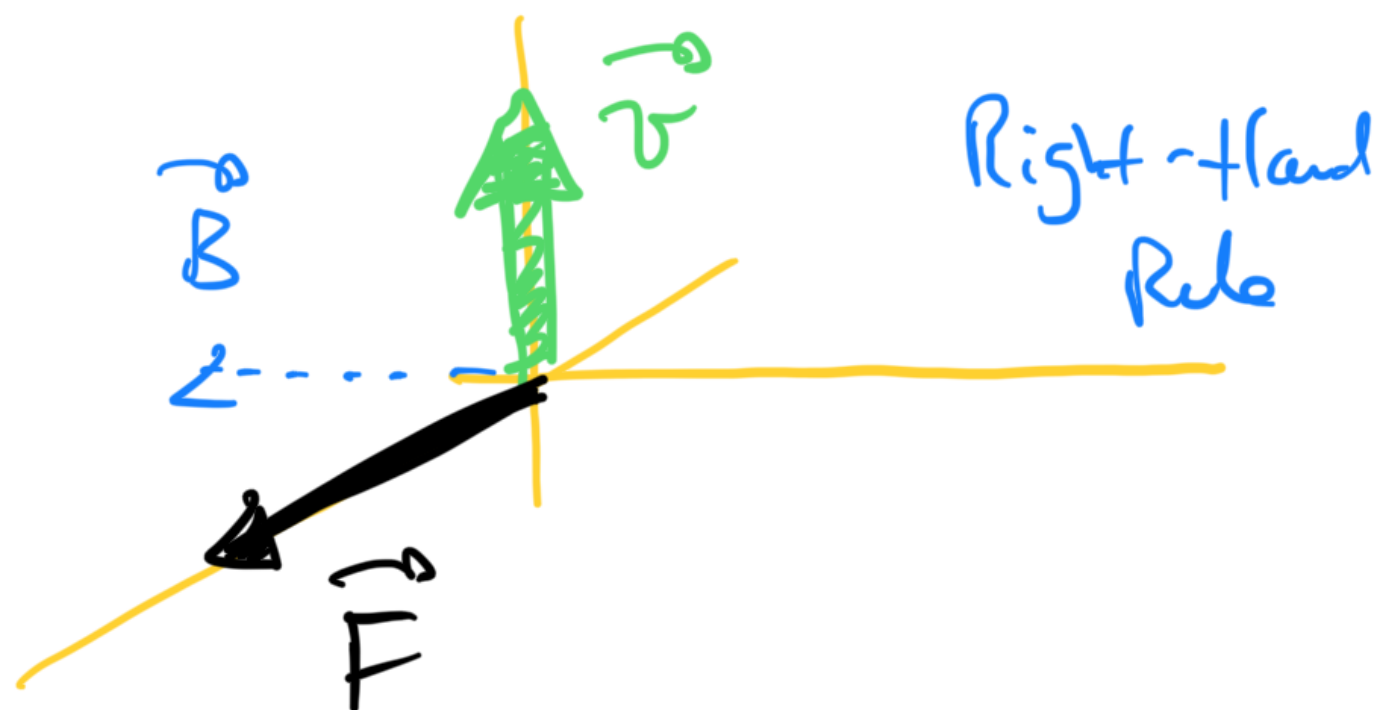
↑  
?

$\boxed{-\hat{j}}$

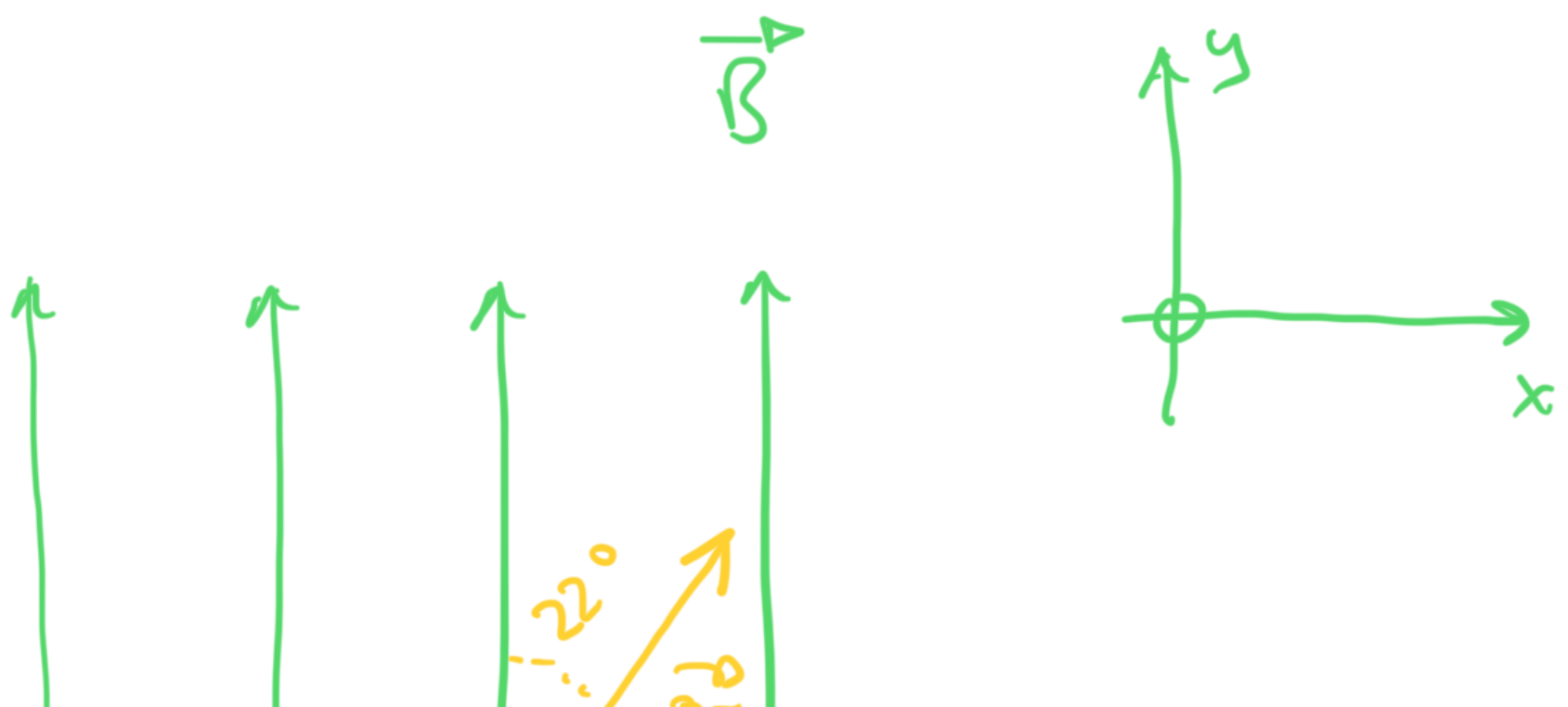
$\hat{k} \times -\hat{j} = \hat{i}$

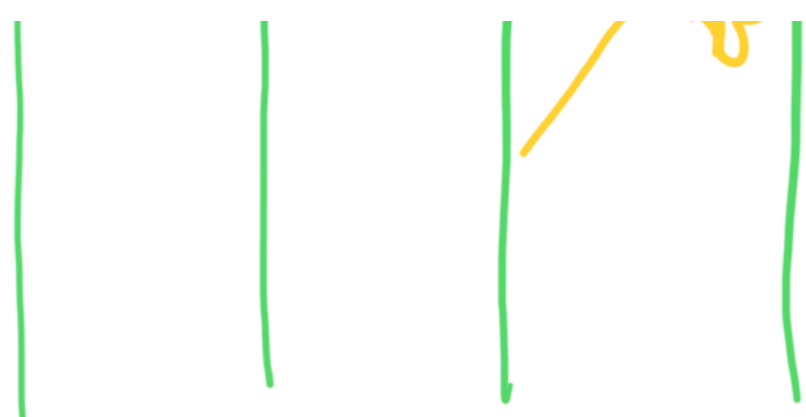
∴  $\vec{B}$  is in -ve y direction.

Alternate:



2.





The diagram shows four vertical green lines representing magnetic field lines. An orange arrow labeled 'v' points upwards, indicating the direction of motion of a charge.

$$\begin{aligned}
 a) \quad |\vec{F}| &= |q| |\vec{v}| |\vec{B}| \sin \theta_{vB} \\
 &= (1.602 \times 10^{-19}) (3 \times 10^6) (0.760) \\
 &\quad \times \sin(22^\circ) \\
 &= 1.37 \times 10^{-13} \text{ N}
 \end{aligned}$$

$$b) \quad |\vec{F}| = m |\vec{a}|$$

$$\begin{aligned}
 |\vec{a}| &= \frac{|\vec{F}|}{m} = \frac{1.37 \times 10^{-13}}{1.672 \times 10^{-27}} \\
 &= 8.18 \times 10^{13} \text{ m/s}^2
 \end{aligned}$$

3.

$$\vec{v} = 5\hat{i} - 6\hat{j} + \hat{k}$$

$$\vec{B} = 1\hat{i} + 2\hat{j} - 3\hat{k}$$

$$\vec{F} = q \vec{v} \times \vec{B}$$

$$\vec{v} \times \vec{B} = (5\hat{i} - 6\hat{j} + \hat{k})$$

$$\times (1\hat{i} + 2\hat{j} - 3\hat{k})$$

$$= \cancel{5\hat{i} \times \hat{i}} + 10\hat{i} \times \hat{j} - 15\hat{i} \times \hat{k} \\ - 6\hat{j} \times \hat{i} - \cancel{12\hat{j} \times \hat{j}} + 18\hat{j} \times \hat{k} \\ + 1\hat{k} \times \hat{i} + 2\hat{k} \times \hat{j} - \cancel{3\hat{k} \times \hat{k}}$$

$$= 10\hat{k} + 15\hat{j} + 6\hat{k} + 18\hat{i} + \hat{j} \\ - 2\hat{i}$$

$$= 16\hat{i} + 16\hat{j} + 16\hat{k}$$

$$|\vec{v} \times \vec{B}| = \sqrt{16^2 + 16^2 + 16^2} = 16\sqrt{3} = 27.71$$

$$|\vec{F}| = |q| |\vec{v} \times \vec{B}| = (1.602 \times 10^{-19}) (27.71) \\ = 443 \times 10^{-18} \text{ N}$$

4.

$$q \Delta V = \frac{1}{2} m v^2$$

$$|\vec{F}| = q \cancel{v} B = \frac{m v^{\cancel{2}}}{r}$$

$$r = \frac{m v}{q B}$$

$$q \Delta V = \frac{1}{2} m v^2 \quad v^2 = \frac{2 q \Delta V}{m}$$

$$v = \sqrt{\frac{2 q \Delta V}{m}}$$

$$r = \frac{m}{q B} \sqrt{\frac{2 q \Delta V}{m}}$$

$$= \sqrt{\frac{m^{\cancel{2}}}{q^{\cancel{2}} B^2} \cdot \frac{2 q \cancel{\Delta V}}{\cancel{m}}}$$

$$r = \sqrt{\frac{2 m \Delta V}{q B^2}}$$

$$r_p = \sqrt{\frac{2 m_p \Delta V}{e B^2}}$$

$$r_d = \sqrt{\frac{2 (2m_p) \Delta V}{e B^2}} = \sqrt{2} r_p$$

$$r_\alpha = \sqrt{\frac{2 (\cancel{4}^2 m_p) \Delta V}{\cancel{2} e B^2}} = \sqrt{2} r_p$$