Phys 202 – A5

1\. a) "perpendicular to" $\rightarrow \Theta_{AB} = 90°$

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

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

d) "proton" : $q = 1.602 \times 10^{-19} C$

$m = 1.672 \times 10^{-27} kg$

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

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

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

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

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

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

$$3.006 \times 10^{-14} = (1.669 \times 10^{-19})(2.10 \times 10^{7})|\vec{B}|(1)$$

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

$$[F] = [q][v][B]\cancel{[\sin\theta]}$$

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

$$= \frac{kg}{C \cdot s}$$

$$\equiv \underline{1} \text{ Tesla}$$

$$= 1\ T$$

Direction:

$$\vec{F} = F\,\hat{i}$$

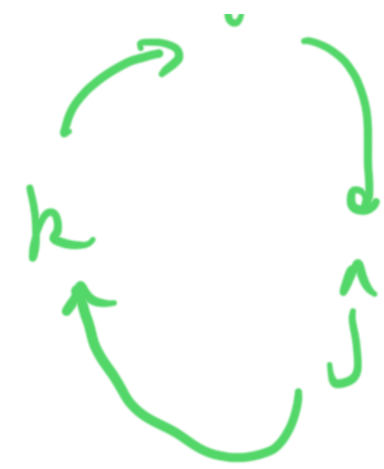
$$\vec{v} = v\,\hat{k}$$

$$\vec{B} = B\,\boxed{?}$$

$$F = q \; v \times B$$

$\hat{i}$ +ve $\hat{k}$?

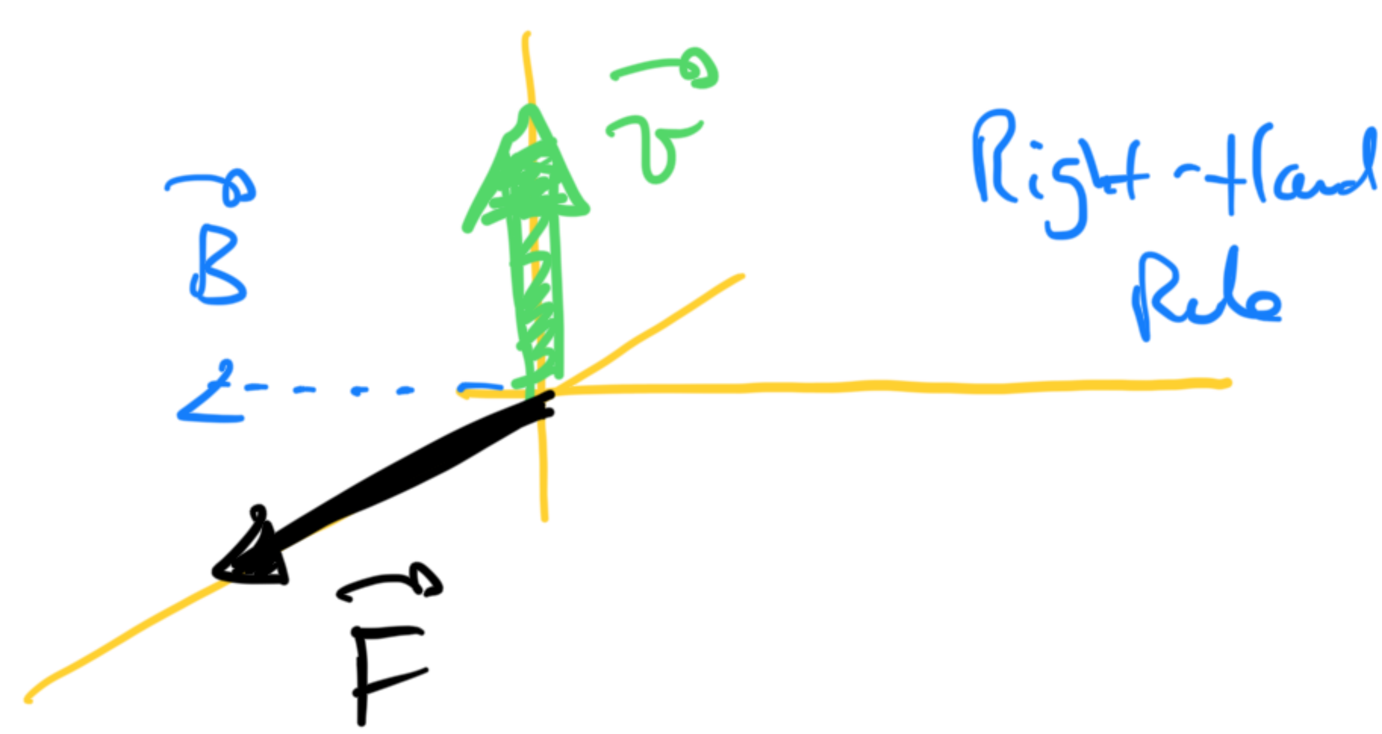
$\boxed{-\hat{j}}$



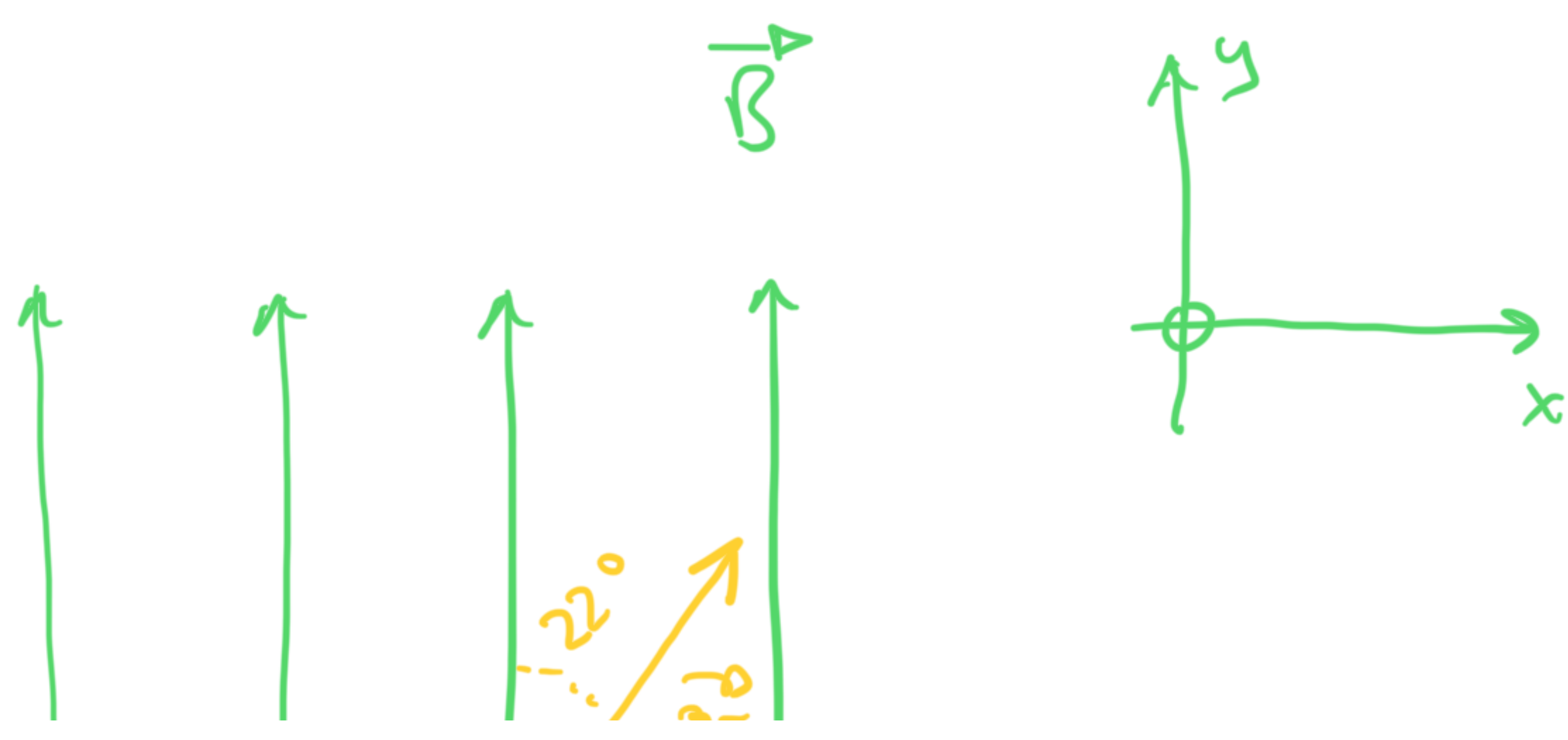
$$\hat{k} \times -\hat{j} = \hat{i}$$

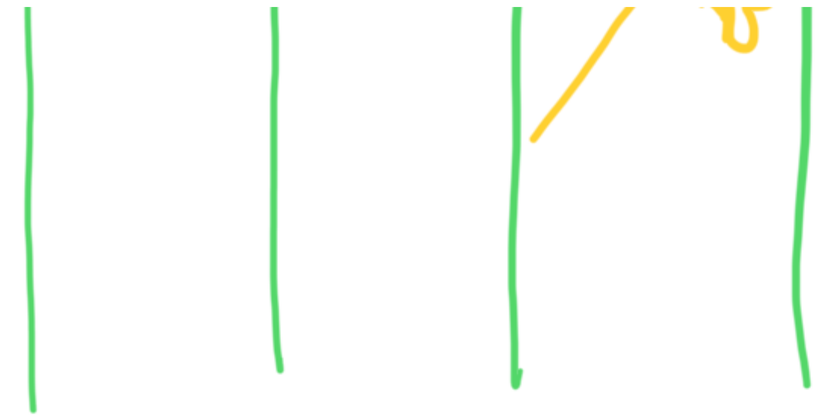
$\therefore \vec{B}$ is in −ve y direction.

Alternate:



2.





a) $|\vec{F}| = |q||\vec{v}||\vec{B}| \sin \theta_{vB}$

$$= (1.602 \times 10^{-19})(3 \times 10^{6})(0.760) \times \sin(22^\circ)$$

$$\approx 1.37 \times 10^{-13} \text{ N}$$

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

$$|\vec{a}| = \frac{|\vec{F}|}{m} = \frac{1.37 \times 10^{-13}}{1.672 \times 10^{-27}}$$

$$= 8.18 \times 10^{13} \text{ m/s}^2$$

3.

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

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

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

$$\vec{v} \times \vec{B} = \left(5\hat{i} - 6\hat{j} + \hat{k}\right) \times \left(1\hat{i} + 2\hat{j} - 3\hat{k}\right)$$

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

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

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

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

$$|\vec{F}| = |q|\,|\vec{v}\times\vec{B}| = (1.602\times10^{-19})(27.71)$$

$$= 4.43\times10^{-18}\ \text{N}$$

4.

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

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

$$\boxed{r = \frac{mv}{qB}}$$

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

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

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

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

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

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

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

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