These are NOT notes. They are a visual aid(20%) for a verbal explanation(80%). A

~~HW~~

25.64)

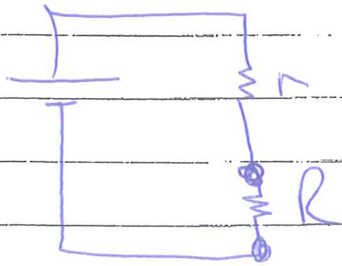
$R = 11 \times 10^3 \ \Omega$ $\quad r = 1600 \ \Omega$

$V = 16 \times 10^3 \ V$

"internal resistance"

SEE CANVAS ANNOUNCEMENT

a) +V



$I = \frac{V}{(R+r)} = \underline{\underline{1.27 \ A}}$

b.) $P = I^2 R = 17.74 \times 10^3$ watts

To Person

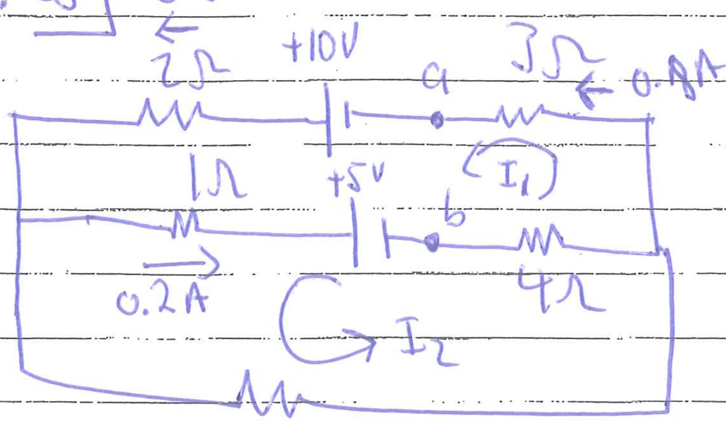
c.) $r = ?$ but $I = 1 \times 10^{-3}$ A

$V = I(R+r)$

$\frac{V}{I} = R + r$

$\therefore r = \frac{V}{I} - R = \frac{16 \times 10^3}{1 \times 10^{-3}} - 11 \times 10^3 = \underline{\underline{16 \times 10^6 \ \Omega}}$

HW 26.28



"Mesh currents"

loop #1

$$-3I_1 + 10 - 2I_1 \underbrace{- 1I_1 + 1I_2}_{V_{1\Omega}} - 5 - 4I_1 + 4I_2 = 0$$

$\boxed{1}$ $-10I_1 + 5I_2 = -5$

loop #2

$$-10I_2 - 4I_2 + 4I_1 + 5 - 1I_2 + 1I_1 = 0$$

$\boxed{2}$ $+5I_1 - 15I_2 = -5$

Consider: $2 * \boxed{2} + \boxed{1}$

$$\cancel{+10I_1} - 30I_2 \cancel{-10I_1} + 5I_2 = -10 - 5$$

$$-25I_2 = -15$$

$$\underline{I_2 = 0.6\,A}$$

$\boxed{2} \Rightarrow I_1 = \dfrac{-5 + 15I_2}{5} = \underline{0.8\,A}$

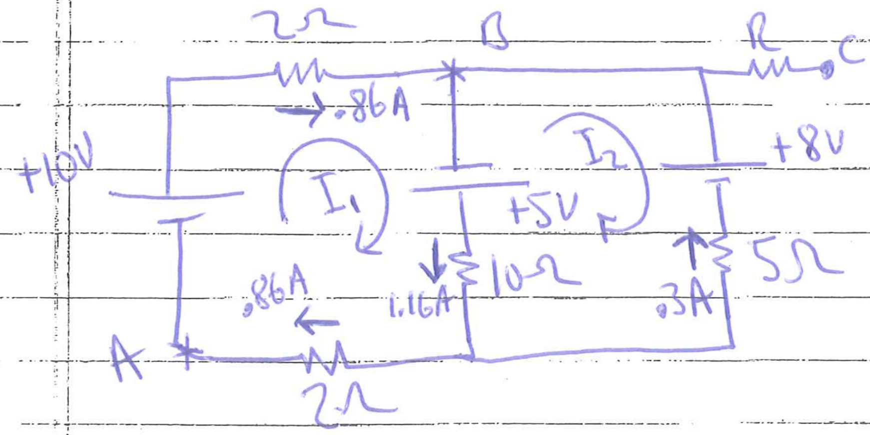
$\Delta V_{a \to b} = +(0.8)(3) + (0.2)(4) = +3.2$ volts

$\Delta V_{b \to a} = -(0.2)(4) - (0.8)(3) = -3.2$ volts

ΔV_{ab}

ΔV_{ba}

Find the current through each resistor.



[Model circuit w/ "mesh currents"

Loop Rule

loop 1

$$\overbrace{+10 - 2I_1}^{\Delta V_{2\Omega}} + 5 \underbrace{-10I_1 + 10I_2}_{\Delta V_{10\Omega}} - 2I_1 = 0$$

$$\boxed{1} \quad -14I_1 + 10I_2 = -15$$

loop 2

$$-8 - 5I_2 \underbrace{-10I_2 + 10I_1}_{\Delta V_{10\Omega}} - 5 = 0$$

$$\boxed{2} \quad +10I_1 - 15I_2 = 13$$

$\boxed{1} \Rightarrow I_2 = \dfrac{-15 + 14I_1}{10}$

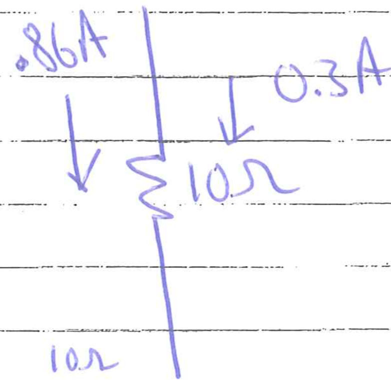
use in $\boxed{2} \Rightarrow 10I_1 - 15\left(\dfrac{-15 + 14I_1}{10}\right) = 13$

$$-11I_1 + 22.5 = 13$$

$$I_1 = 0.86 \text{ amps}$$

$\therefore I_2 = \frac{-15+14I_1}{10} = -0.3$ amps

For 10Ω :



$\therefore I_{10\Omega} = 1.16A$ down

$(1.16)^2$ 10Ω

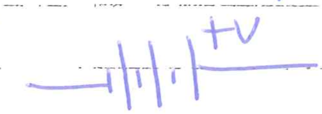
$Power_{10\Omega} = I^2R = 13.5W$

$\Delta V_{A\to B} = +10 - 0.86(2) = 8.28V$

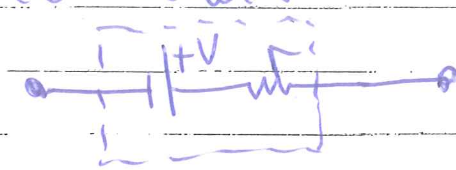
$\Delta V_{B\to C} = -(0)R = 0\,V$

Electromotive Force (EMF)

↳ Perfect Battery



Real batteries



Ch. 27/28 Magnetism

"Electricity + Magnetism" ⇒ ☺ Always a pair?
E + M

✯ All currents create magnetic fields.
All magnetic fields are created by currents ✯

Aside: "Gravitational Field" → A mass in a space so 'disturbed' experiences a force

"Electric Field" → A charge ... ☺

"Magnetic Field" → A magnet ... ☺

* $\boxed{\text{AND}}$ a moving charge experiences a force in a direction that is perpendicular to its motion (velocity)

Magnetic field, $\vec{B}$ tesla (T) SI,
gauss (G)

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

↑ velocity

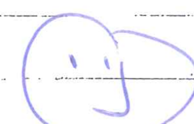
$\vec{v} \times \vec{B}$ is a "vector cross product" (Ch. 1)

$$\vec{V} = V_x\hat{i} + V_y\hat{j} + V_z\hat{k}$$

$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

$$\vec{V}\times\vec{B} = \begin{array}{ccc} + & - & + \end{array}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ V_x & V_y & V_z \\ B_x & B_y & B_z \end{vmatrix} = +\hat{i}\begin{vmatrix} V_y & V_z \\ B_y & B_z \end{vmatrix} - \hat{j}\begin{vmatrix} V_x & V_z \\ B_x & B_z \end{vmatrix} + \hat{k}\begin{vmatrix} V_x & V_y \\ B_x & B_y \end{vmatrix}$$

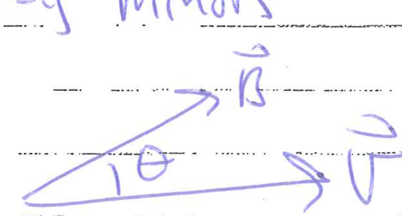
$$\vec{V}\times\vec{B} = \underbrace{+\hat{i}(V_yB_z - B_yV_z) - \hat{j}(V_xB_z - B_xV_z) + \hat{k}(V_xB_y - B_xV_y)}_{\text{is } \perp \text{ to BOTH } \vec{V} \text{ and } \vec{B}}$$



$\vec{F} = q\vec{v}\times\vec{B}$ w/ expansion by minors

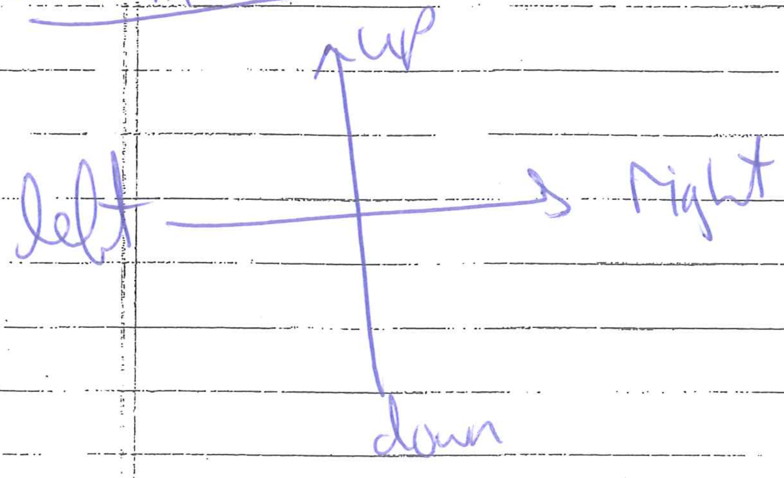
OR

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



w/ direction assigned by a "right hand rule!"

Conventin



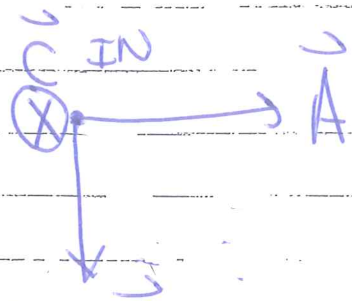
X IN ⊗

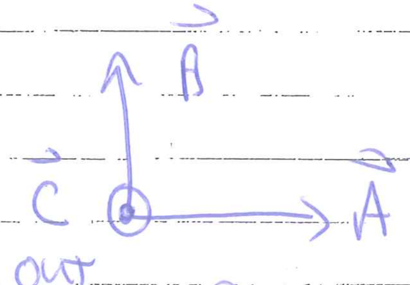
· OUT ⊙

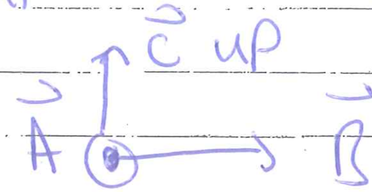
IN to page
out of the page

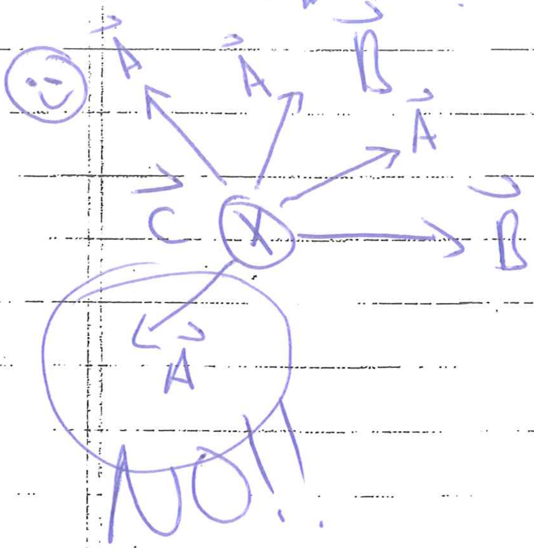
Given: $\vec{C} = \vec{A} \times \vec{B}$.

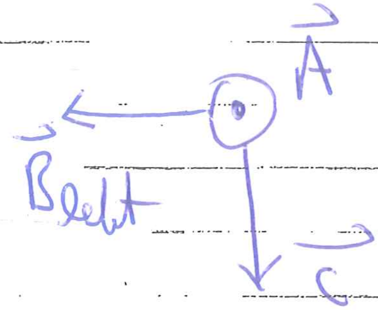
"rt. hand rule"



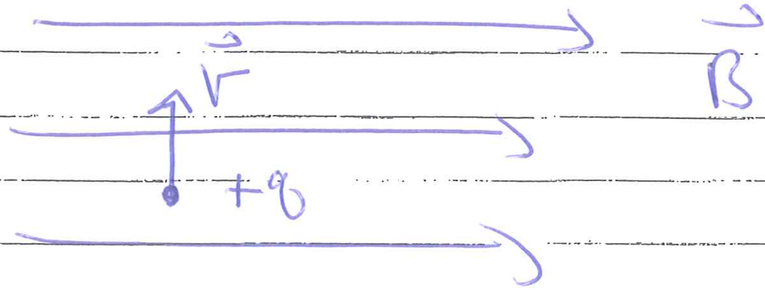








$\vec{F} = q\vec{v} \times \vec{B}$ ☆



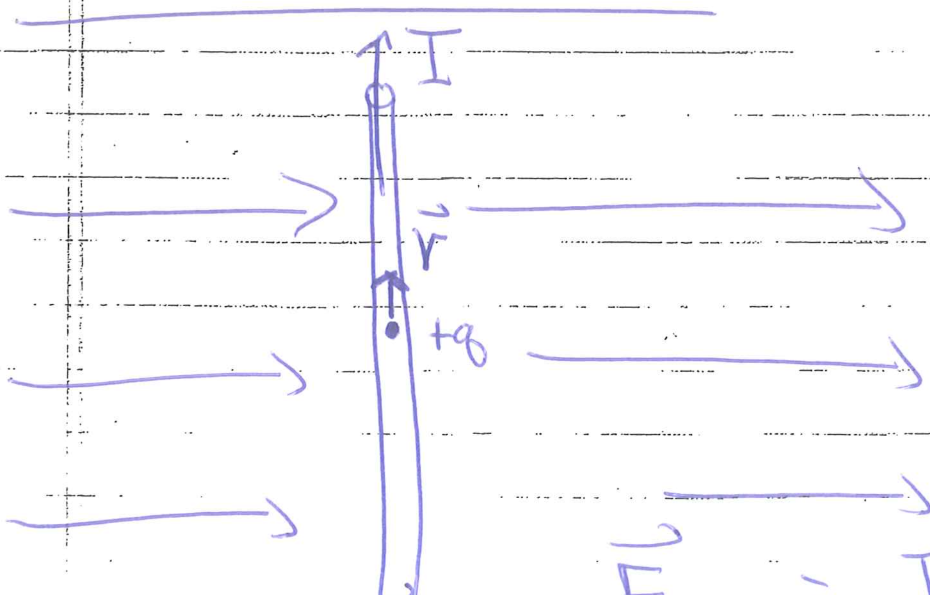
$\vec{B}$ right
$\vec{v}$ up
$\vec{F}$ IN

Positive Charge

What if q was negative?

$\vec{F} = (-q)\vec{v} \times \vec{B}$

$\vec{B}$ right
$\vec{v}$ up
$\vec{F}$ OUT!!



$\boxed{\text{HW}}$ ☆
"Super position"

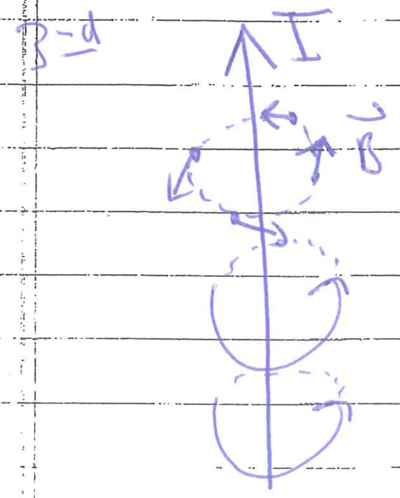
$\vec{F}_{wire} = I\vec{\ell} \times \vec{B}$ ☆

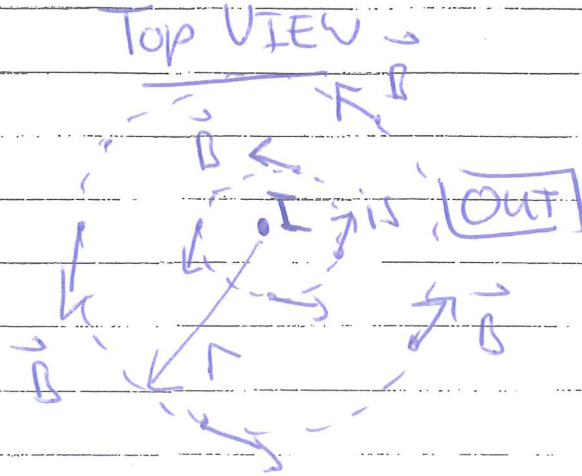
$\boxed{\text{IN}}$

$|\vec{\ell}|$ is length of wire IN Direction of current

Paris ~ 1800

$\vec{B}$ produced by wire carrying a current I:



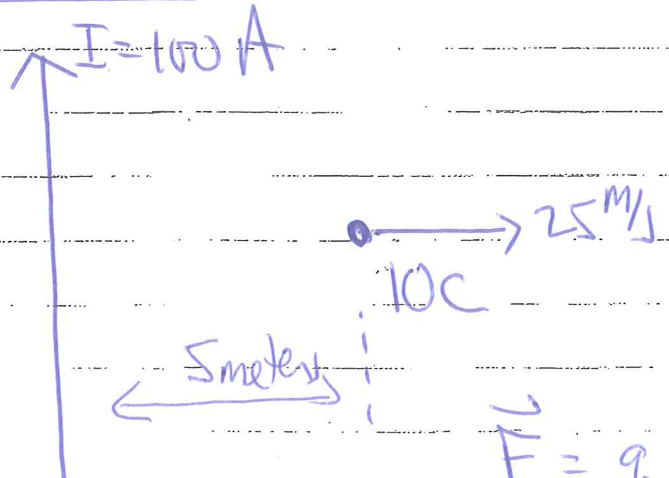


= Emperical (it worked)

$$|\vec{B}|_{wire} = \frac{\mu_0 I}{2\pi r}$$

μ_0 = permeability of free space ($4\pi * 10^{-7}$)

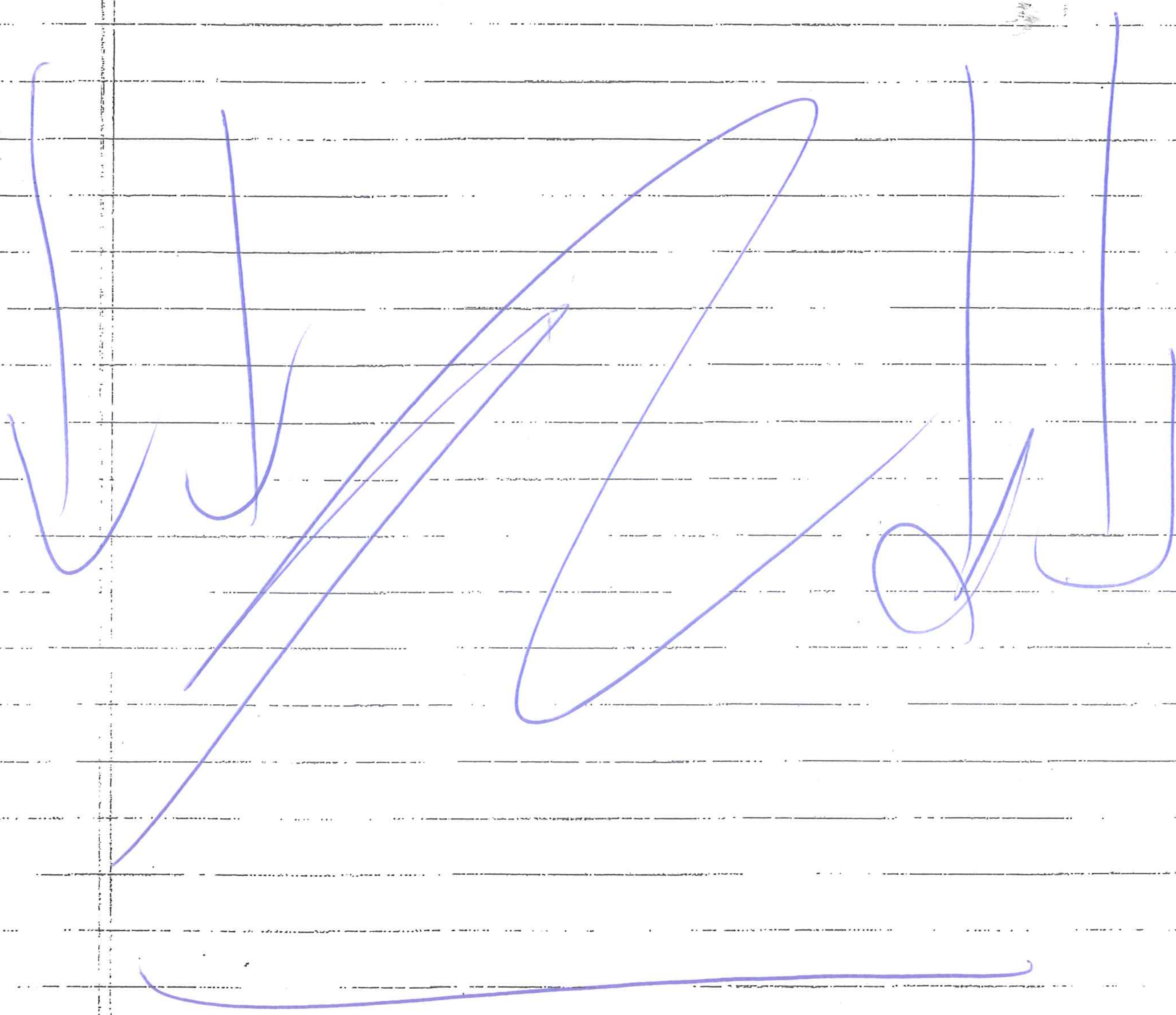
Ex)



At this instant in time, what is the magnetic force on the charge?

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

@ location of q, $\vec{B} = \frac{\mu_0 I}{2\pi r} = \frac{4\pi * 10^{-7}(100)}{2\pi(5)}$ $\boxed{IN}$



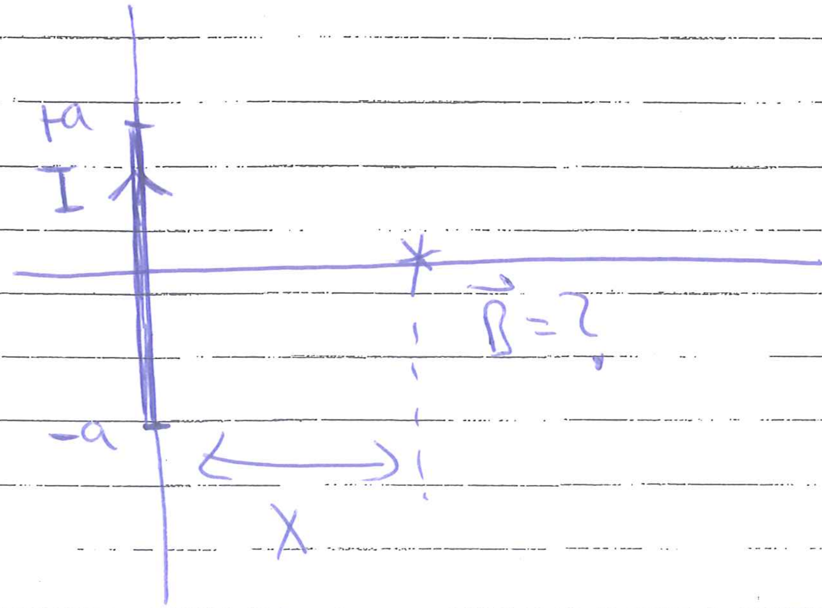
$\vec{B} = 4\times10^{-6}$ tesla $\boxed{IN}$ @ q.

$\therefore\ \vec{F} = (10)(25\ \boxed{right}) \times (4\times10^{-6}\ \boxed{IN})$ } ? You OK?

$[q|\vec{v}||\vec{B}|\sin\theta] \Rightarrow 10(25)(4\times10^{-6})\sin(90)\ \boxed{UP}$

$= 1\times10^{-3}$ Newtons $\boxed{UP}$ ANSWER

EX] A wire of length 2a carries a current I. What is $\vec{B}$ a distance x from its mid point?



$\cancel{\frac{\mu_0 I}{2\pi r}}$ "short wire"

Biot-Savart Law

a small step in direction of I

$$d\vec{B} = \frac{\mu_0 I}{4\pi r^2} \, d\vec{l} \times \hat{r}$$