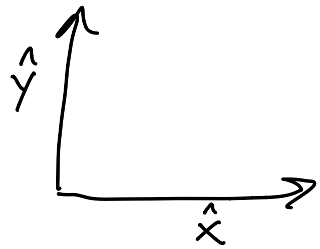
Finish Cross Product

$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$

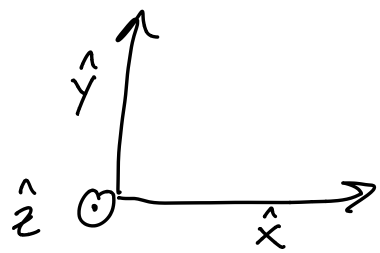
Q: What is $\hat{x}\times\hat{y}$?



mag 1,

dir

$\odot$

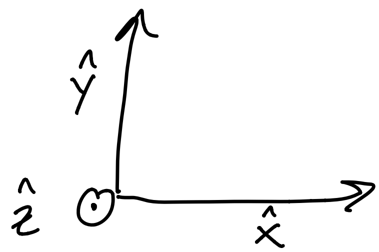


What about $\hat{y}\times\hat{z}$?

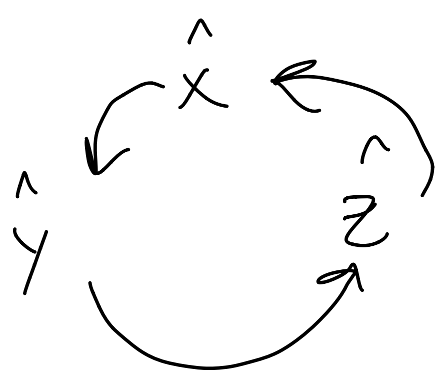
$\hat{x}$

$\hat{x}\times\hat{x}$? 0

table



		$\hat{x}$	$\hat{y}$	$\hat{z}$	$\vec{B}$
	$\hat{x}$	0	$\hat{z}$	$-\hat{y}$	
$\vec{A}$	$\hat{y}$	$-\hat{z}$	0	$\hat{x}$	
	$\hat{z}$	$\hat{y}$	$-\hat{x}$	0	



ccw = +

cw = −

$$\vec{A} = \langle A_x, A_y, A_z \rangle$$

$$\vec{B} = \langle B_x, B_y, B_z \rangle$$

$$\vec{A} \times \vec{B} = \left(A_x \hat{x} + A_y \hat{y} + A_z \hat{z} \right) \times$$

$$\left(B_x \hat{x} + B_y \hat{y} + B_z \hat{z} \right)$$

$$= A_x \hat{x} \times B_x \hat{x} + A_x \hat{x} \times B_y \hat{y} + A_x \hat{x} \times B_z \hat{z}$$

$$+ A_y \hat{y} \times B_x \hat{x} + A_y \hat{y} \times B_y \hat{y}$$

$$+ A_y \hat{y} \times B_z \hat{z}$$

$$+ \quad \ldots$$

Defn

$$
\begin{array}{l|l}
= A_x B_x\, \hat{x} \times \hat{x} & 0 \\
+ A_x B_y\, \hat{x} \times \hat{y} & A_x B_y\, \hat{z} \\
+ A_x B_z\, \hat{x} \times \hat{z} & -A_x B_z\, \hat{y} \\
+ \; \ldots &
\end{array}
$$

$$\vec{A} \times \vec{B} =$$

$$\langle A_y B_z - A_z B_y,\; A_z B_x - A_x B_z,\; A_x B_y - A_y B_x \rangle$$

$$|\vec{A} \times \vec{B}| = |\vec{A}||\vec{B}| \sin\theta$$

On Wednesday:

$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$$

Biot-Savart Law

$$\frac{\mu_0}{4\pi} = 10^{-7} \frac{T \cdot m^2}{C \cdot m/s}$$

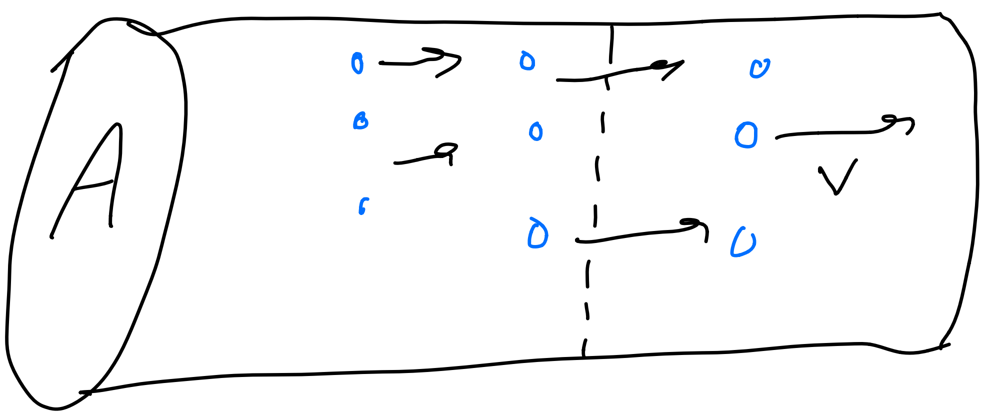
Usually we deal with a large number of moving charges (currents)

Suppose I have a metal wire

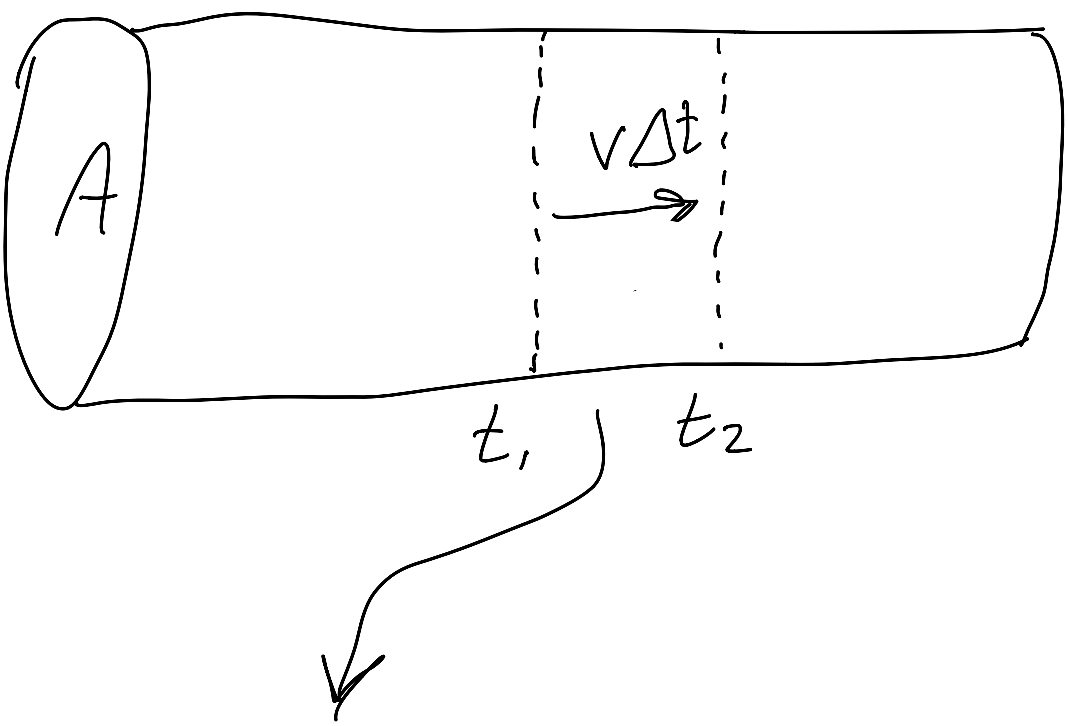
- cross-sectional area A

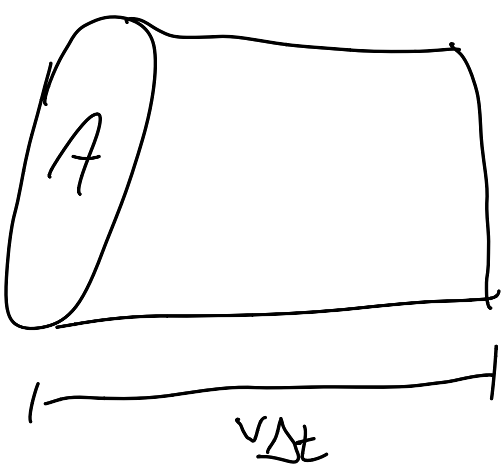
- electrons moving with avg velocity v

- density n



# of electrons crossing this section in time Δt?





$$V = Av\Delta t$$

# of electrons / volume $= n$

Volume $= A v \Delta t$

$$N_e = n A v \Delta t$$

$$\frac{N_e}{\Delta t} = n A v \equiv i$$

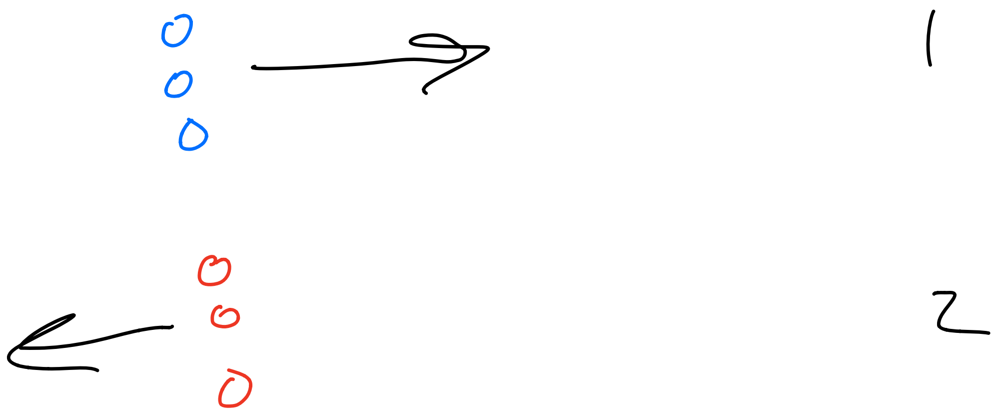
$$\boxed{\begin{array}{c} i = n A v \\ \text{Electron Current} \end{array}}$$

Question: if I have an electron current of i, $\left(\frac{Ne}{t}\right)$, what is $\frac{Q}{\Delta t}$?

- should be $-ei$ right?

- when current was discovered, didn't know it was electrons that were moving

Because $\vec{B} = \frac{\mu_0}{4\pi} q \frac{\vec{v} \times \hat{r}}{r^2}$



$$q\vec{v} = (-q)(-\vec{v})$$

B. Franklin thought it was #2

Defined current

$$I = |q| n A v$$

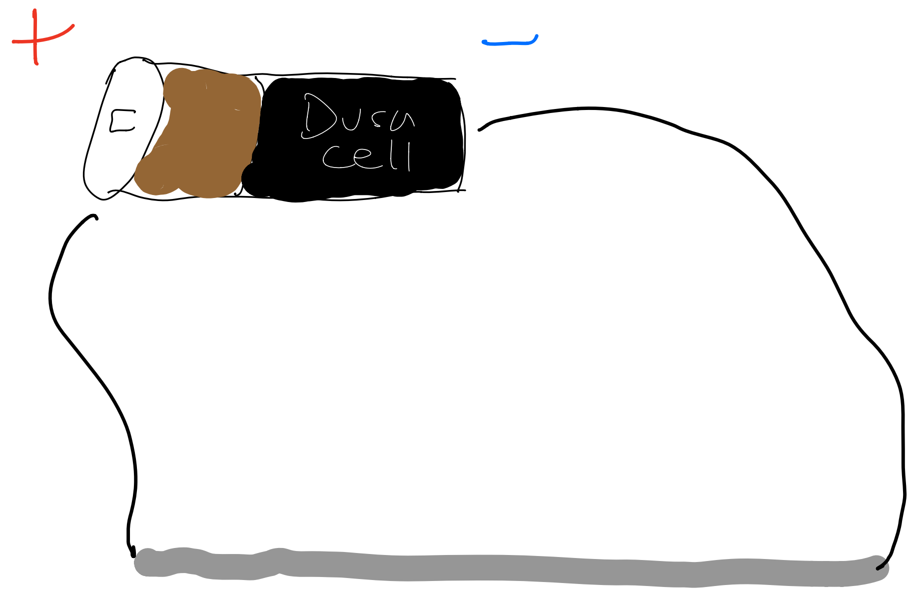
$$I = |q| i$$

$$I = |q| n A v$$

$$I = |q| i$$

Conventional Current

Draw



Conventional
Current
$I = |q| i$

electron
current
i