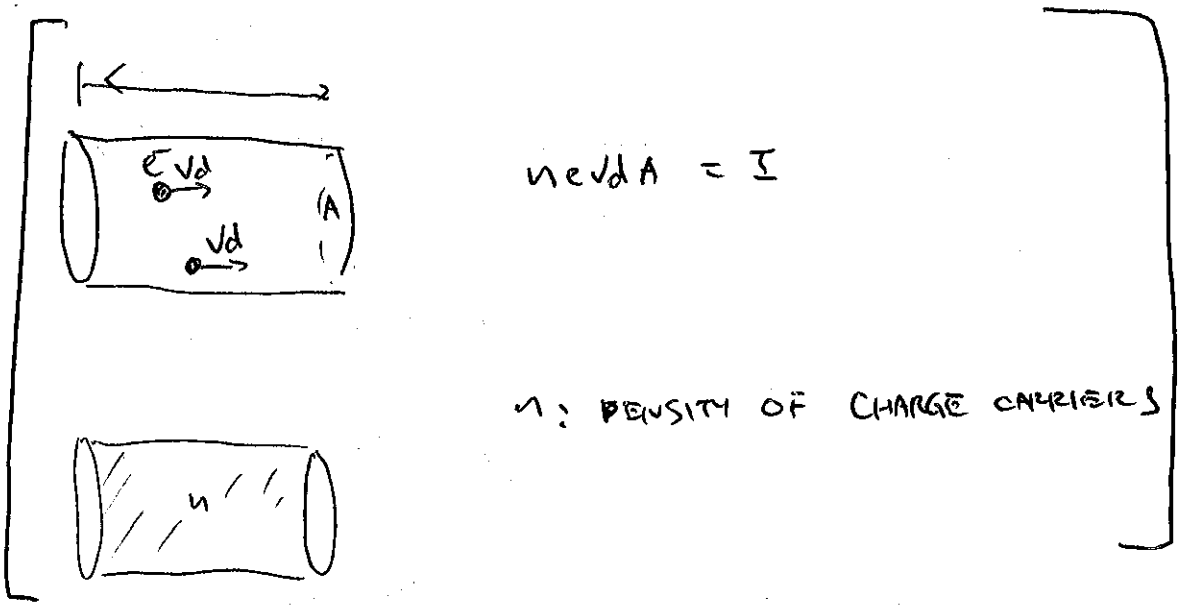
LECTURE 2/13/09

CURRENT AND RESISTANCE

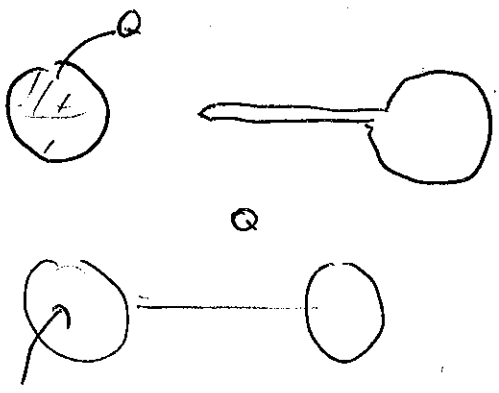
CURRENT $I = \frac{dQ}{dt}$ $1A \quad 1C/s$



$nevdA = I$

n : DENSITY OF CHARGE CARRIERS

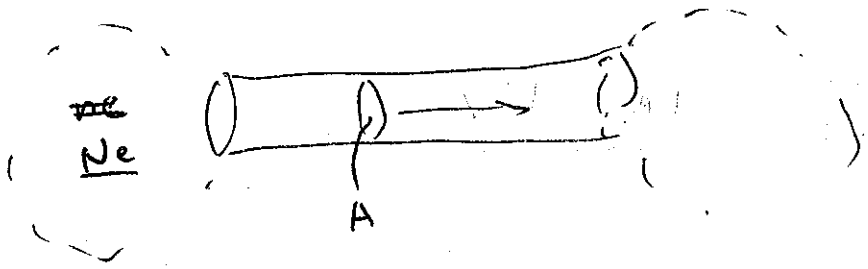
IF Q



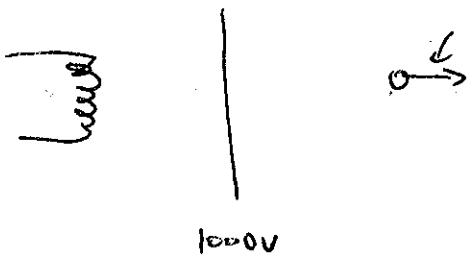
$\frac{dQ}{dt} = I$

CHARGE IS CARRIED BY A CARRIER.

ELECTRON



WHAT'S THE SPEED OF CHARGE CARRIER.?



eV

1000 eV

$1000\ eV = \frac{1}{2}mv^2$

VELOCITY.

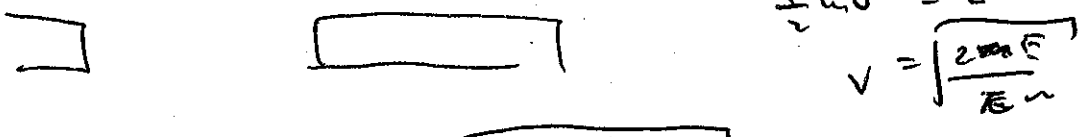
$$\frac{2 \times 100 \times 1.6\times10^{-19}}{9.11\times10^{-31}} = v^2$$

$$3200 \times 10^{12} = V$$

$1.7\times10^{7}\ m/s$ Ve.

WHAT IS V IN SOLID?

IS ARE ELECTRONS MOVING AS FAST AS IN VACUUM!



$\frac{1}{2}mv^2 = E$

$v = \sqrt{\frac{2E}{m}}$

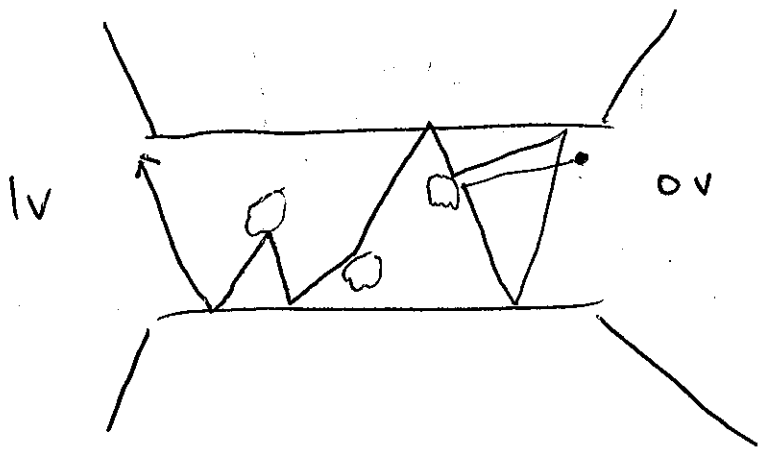
1eV ? $\sqrt{\frac{1.6\times10^{-19}\times 2}{9.109\times10^{-31}}} = V =$

$\sqrt{0.35\times10^{12}}$

$0.5\times10^{6}\ m/s = V$?

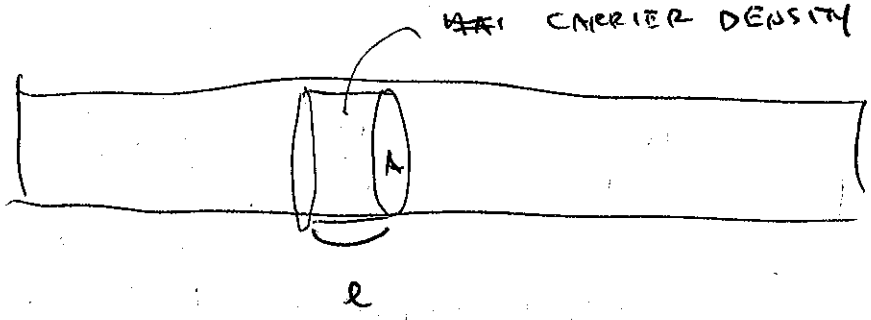
BUT IN REALITY, ~3. mm/sec WHY?

SCATTERING



Vd: DRIFT SPEED

AVERAGE SPEED OF CARRIERS IN SOLID



$n\ell A$ = TOTAL NUMBER OF CARRIERS

CURRENT : $\frac{\Delta Q}{\Delta t}$

$\Delta Q = n\ell A e$

$\Delta t = \frac{\ell}{V_d}$

$\frac{\Delta Q}{\Delta t} = \frac{n\ell A e}{\ell} V_d$

$$I = nV_d A e.$$

EXAMPLE #1

COPPER MOLECULAR MASS = 63.5 g/mol

$\rho = 8.925 \text{ g/cm}^3$

AVOGADRO'S # 6.022×10^{23}

12 GAUGE WIRE

CROSS SECTIONAL

AMERICAN WIRE GAUGE

1 AWG DIAMETER 0.2893"

12 " AWG DIAMETER 0.0808

$A = 3.31 \times 10^{-6} \text{ m}^2$

CARRIES 10A OF CURRENT

CURRENT DENSITY $\Rightarrow 10\text{A} / 3.31 \times 10^{-6} \text{ m}^2 = 3 \times 10^{6} \text{ A/m}^2$

$u = \frac{6.022 \times 10^{23}}{}$

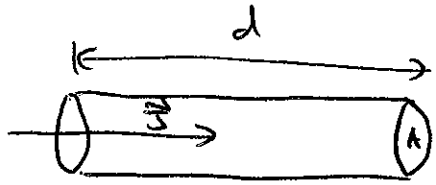
$2.23 \times 10^{-4} \text{ m/s}$

RESISTANCE

J = CURRENT DENSITY $= \frac{I}{A}$

OHM'S LAW:

$\vec{J} = \sigma \vec{E}$ $\quad \sigma$: CONDUCTIVITY



$J = \sigma \vec{E}$

$\frac{\vec{J}}{\sigma} = \vec{E}$ $\qquad \frac{Jd}{\sigma} = V$

$\frac{I}{A}\frac{d}{\sigma} = V$

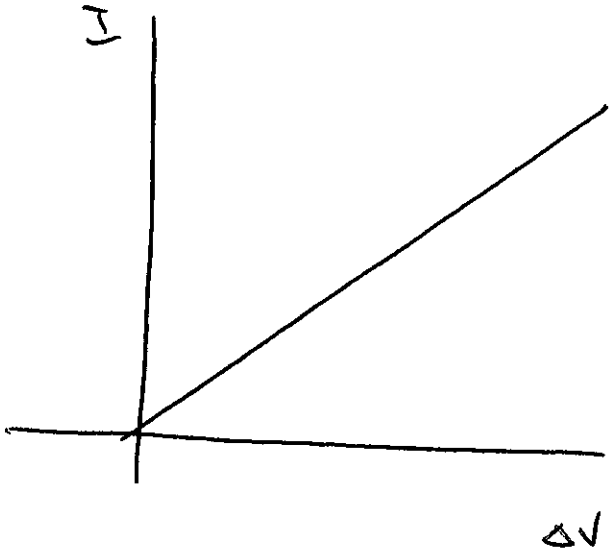
$I\left(\frac{d}{A\sigma}\right) = V$

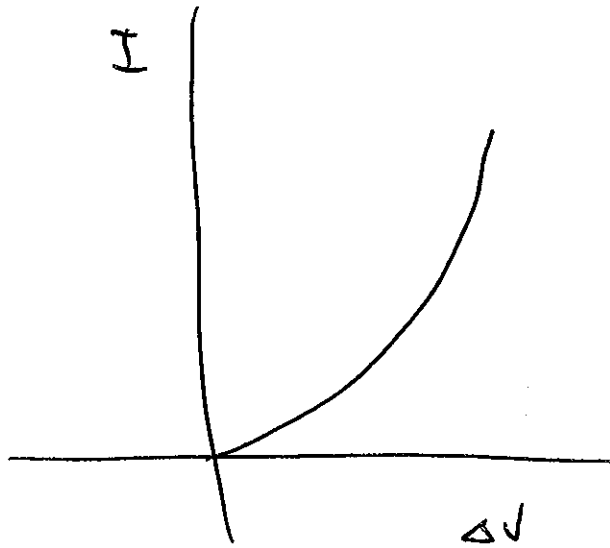
$\frac{V}{I} = R$

$R = \frac{d}{A\sigma}$

$R = \frac{\rho d}{A}$

$\rho = \frac{1}{\sigma}$





RESISTIVITY = $\rho = R \cdot \frac{A}{d}$

= OHM · m

SILVER	$1.59 \times 10^{-8}\ \Omega \cdot m$
COPPER	$1.7 \times 10^{-8}\ \Omega \cdot m$
GOLD	$2.44 \times 10^{-8}\ \Omega \cdot m$
QUARTZ	$75 \times 10^{16}\ \Omega \cdot m$