Derivation
charge
In the figure above, charge carriers, each with chard $q$, move past point P with a speed $v$.
a) In one second, the volume of charge $V O L U M C=A \cdot l$ carriers passing $P$ is equal to
b) The total number of charge carriers in this volume is
$n(A \cdot l)$
\# of charge carriers " $n$ " $\times$ volume
c) The total charge of the charge carriers in this volume is

$$
I=\frac{q}{q} t
$$

d) Therefore, the current is

$$
V=d / t \text { or }(t / t=V
$$

$$
I=q n A(t)=q \cap A V=I
$$

$$
a_{0}=n V
$$

of charge (Liners
8. A copper wire of diameter 0.65 mm carries a current of 0.25 A . There are $8.5 \times 10^{28}$ charge carriers in each cubic meter of copper. Calculate the drift speed of the charge carriers.

$$
A=\pi r^{2}
$$

$$
V=\frac{I}{q n A}
$$

$$
\frac{(0.25 \mathrm{~A})}{\left.\left(8.5 \times 10^{28} / \mathrm{m}^{3}\right)(\pi) \frac{0.65 \times 10^{-3} \mathrm{~m}}{2}\right)^{2}\left(1.6 \times 10^{-19} \mathrm{C}\right)}=
$$

$$
\begin{aligned}
& \times 10^{28} \text { charge } \\
& \text { carriers. } \\
& \times 10^{-19} \mathrm{C}
\end{aligned}=5.5 \times 10^{-5} \frac{\mathrm{~m}}{\mathrm{~s}}
$$

9. If the drift velocity is so small, why does the light bulb light as soon as the battery is connected?


Conduction electrons already in the filament start to move as soon as the electric field is set up in the circuit by the battery. It is these electrons, not the electrons from the battery, that collide with the lattice ions in the filament immediately and transfer enough energy to them to make the filament glow.


Resistance of a Wire

1. What is the cause of resistance in a wire? collisions between conduction electrons + lattice ions

Symbol:
Unit: $\Omega$ ohm $\square$

usually higher temp = higher resistance

$$
\begin{aligned}
& D=\text { \#ot-chage carries } \\
& { }^{d}{ }^{d} \bar{V}=(A \cdot D)
\end{aligned}
$$

## Formula for a


conducting wire at a constant temperature . . .

$$
R=\frac{P L}{A}=\frac{P L}{W \cdot h}=\frac{P L}{\pi r^{2}}
$$


2. What are the properties of wire that is the best conductor (has the least resistance)?
cold, short, wide
3. What are the properties of wire that is the worst conductor (has the most resistance)? warm, long, thin
4. What material would you use to make a wire with the:
a) least resistance SilVer

$$
\begin{aligned}
& \text { metal alloy } \\
& =\text { nichrome }
\end{aligned}
$$

5. What is the resistance of a copper wire 2.0 meters long with a cross-sectional area of $6.4 \times 10^{-8} \mathrm{~m}^{2}$ ?

$$
R=\frac{\rho L}{A} \frac{\left(1.7 \times 10^{-8} \Omega \cdot \mathrm{~m}^{\prime}\right)(2.0 \mathrm{~m})}{6.4 \times 10^{-8} \mathrm{ma}^{2}}=0.53 \Omega
$$

6. a) What is the resistance of a nichrome wire 12 meters long with a diameter of $2.7 \times 10^{-4}$ meter?
$1.5 \times 10^{-6} \Omega \cdot \mathrm{~m}$

$$
R=\frac{\left(1.5 \times 10^{-6} \Omega \mathrm{~m}\right)(12 \mathrm{~m})}{\pi\left(\frac{1}{2} .2 .7 \times 10^{-4} \mathrm{~m}\right)^{2}}=314 \Omega
$$

b) If the diameter of the wire above is doubled, what is its resistance?

## $R=\frac{P L}{\pi(2 r)^{2}}$ <br> resistance would be $\frac{1}{4}$ as much

## Simple Circuits

## Schematic:

Draw a corresponding schematic diagram using appropriate Circuit Symbols.


Schematic
Diagram of
Circuit

Actual
Circuit


Schematic
Diagram of
Circuit

