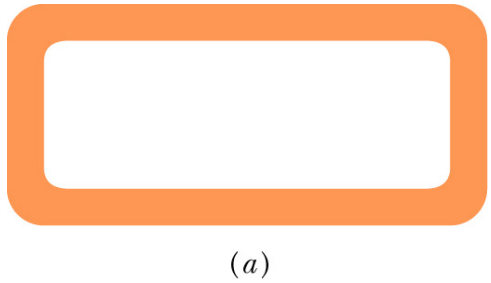
Physics 122: Electricity & Magnetism – Lecture 11 Current & Resistance

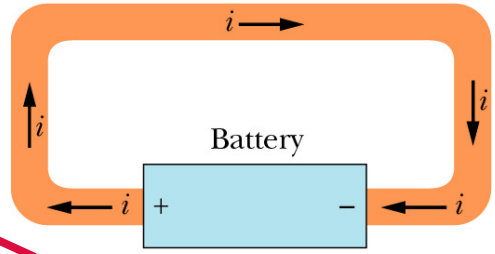
Baris EMRE

Definition of Current

Units: ampere
1 A = 1 C/s



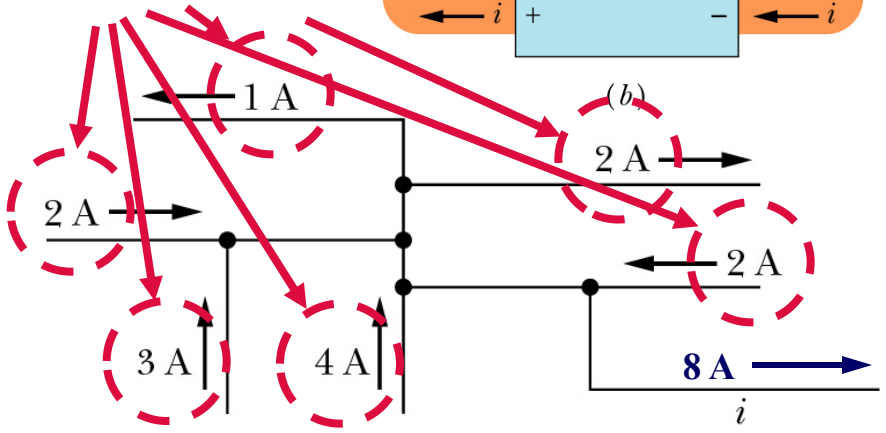
(a)



(b)

11 A − 3 A = 8 A

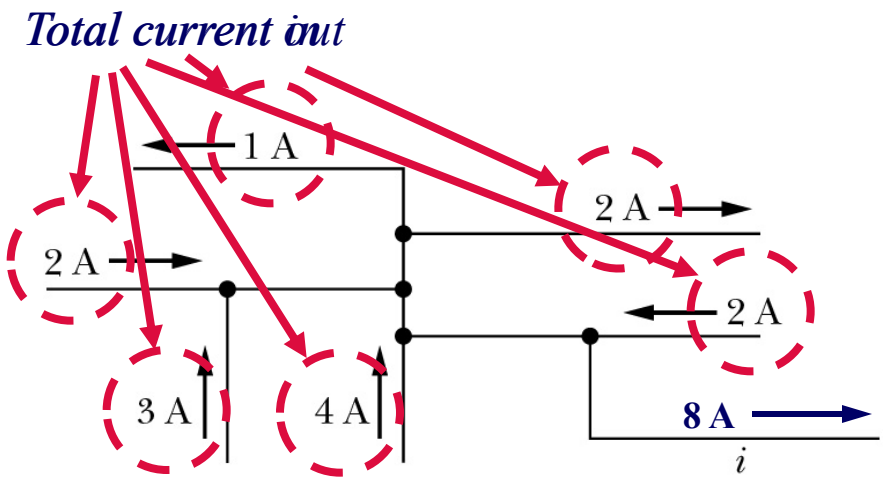
Total current out



Current in a Circuit

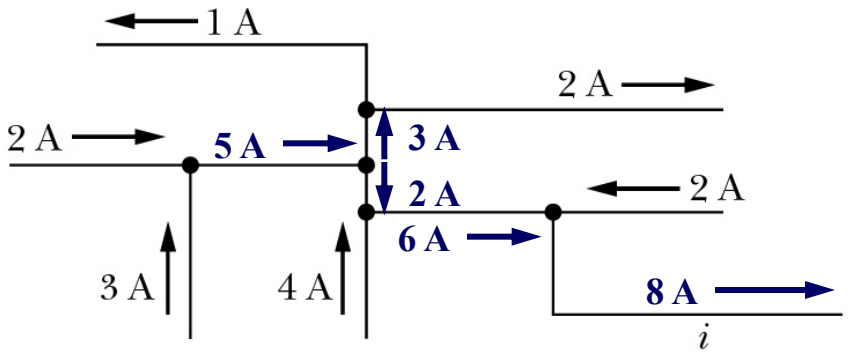
- What is the current in the wire marked i in the figure below?

$$11\ A - 3\ A = 8\ A$$



Current At Junctions

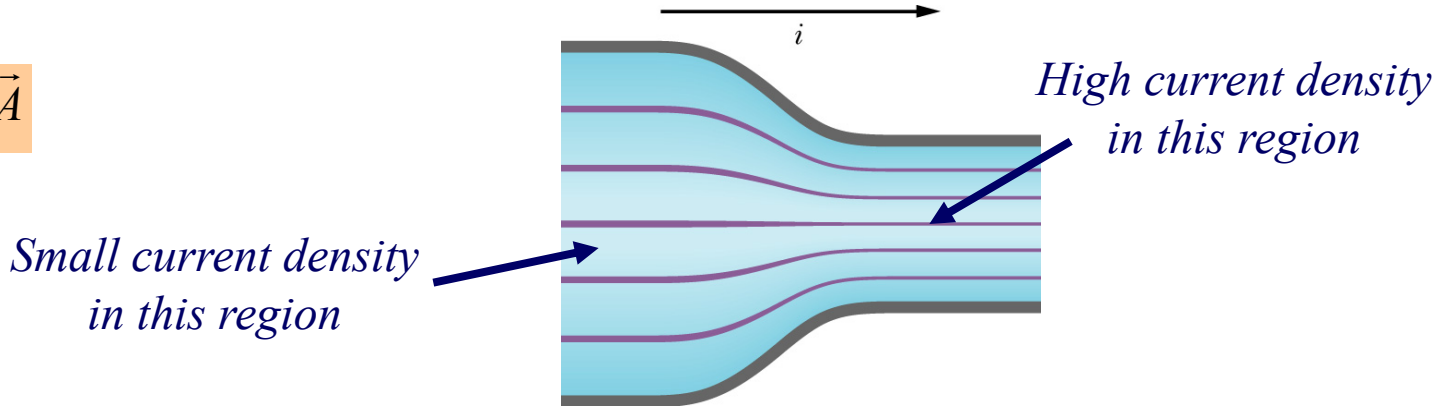
- What is the current in all of the wire sections that are not marked?



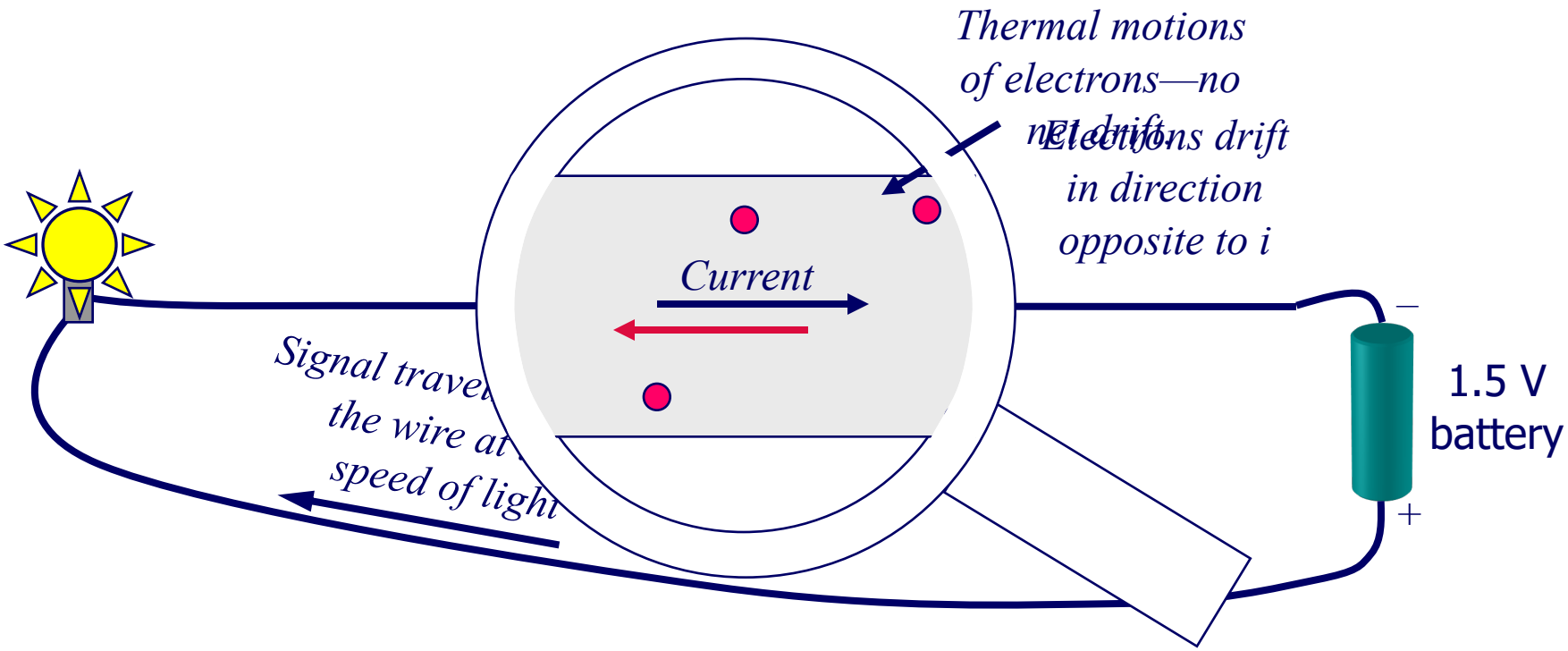
Current Density

$\vec{J}$

$$i = \int \vec{J} \cdot d\vec{A}$$

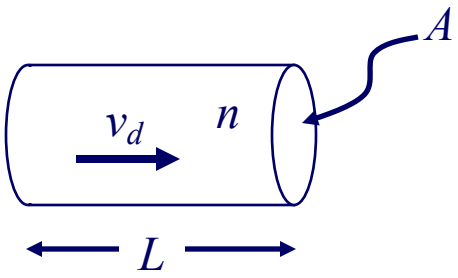


Drift Speed


Thermal motions
of electrons—no
net drift
Electrons drift
in direction
opposite to i
Current
Signal travel
the wire at
speed of light
–
+
1.5 V
battery

Drift Speed

$$v_{th} \approx 10^6 \text{ m/s}$$



Total charge q in volume V

$$q = \frac{N}{V} Ve = nVe = nALe$$

density of charge carriers

$$L = v_d t \quad \therefore \quad q = nAv_d te$$

time to drift a distance L

$$i = \int \vec{J} \cdot d\vec{A} = \frac{dq}{dt} = neAv_d$$

$$\vec{J} = ne\vec{v}_d$$

$+e$ means J and v_d in same direction
$-e$ means J and v_d in opposite directions

ne is carrier charge density ρ

Resistance

- Resistance is defined to be how much current i results. $R = \frac{V}{i}$. That is, we apply a voltage V, and ask This is called Ohm's Law.
- If we apply the voltage to a conducting wire, the current will be very large so R is small.
- If we apply the voltage to a less conducting material, such as glass, the current will be tiny so R is very large.
- The unit of resistance is the ohm, Ω. (Greek letter omega.)

1 ohm = 1 Ω = 1 volt per ampere = 1 V/A