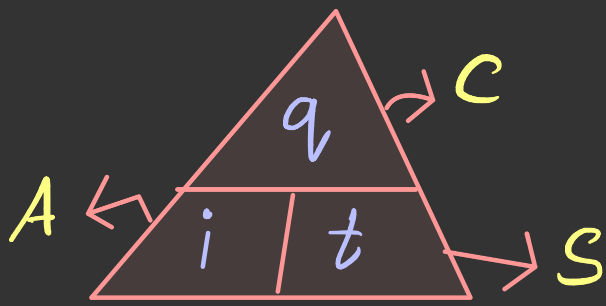
Electric Current

+Ve Charges

Current

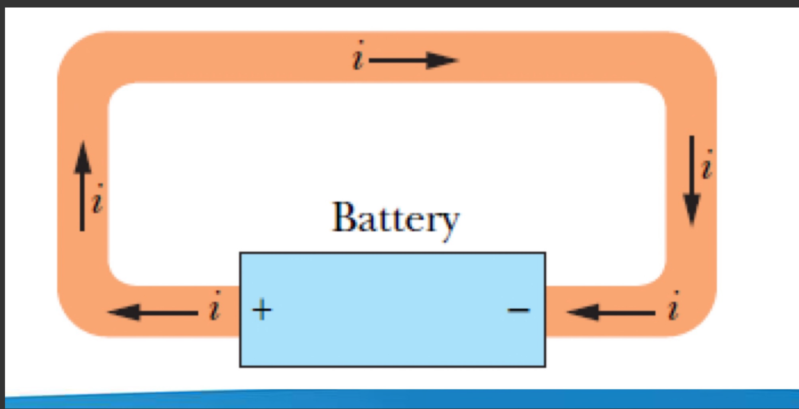
$$i = \frac{q}{t}$$

Time



* SI Unit of the Current is Ampere "A"

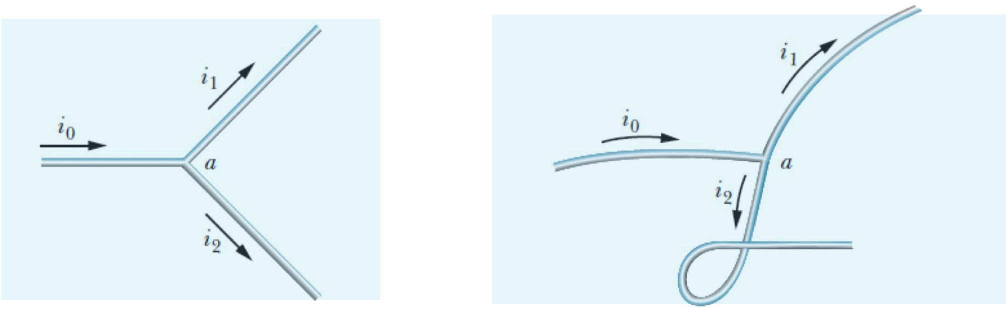
* the direction Of the Current moves from the +Ve to the -Ve



The Directions of Currents

➢ The current into the junction must equal the current out (charge is conserved).

$$i_0 = i_1 + i_2$$



Current Density

$$J = \frac{i}{A}$$

A/m^2 ← Current denisty ← J | i | A → Area → m^2

i → Current → A

Example 1:

10×10^{-3} m

A cylindrical wire of radius 10 mm has a current of 2 A. The current density in the wire is:

$J = \frac{i}{A}$

Solution:

$J = \frac{2}{3.14\times10^{-4}} = 6.369\times10^{3}$

$A = \pi R^2$

$A = 3.14\times10^{-4}$

$J \approx 6.4\times10^{3}\ A/m^2$

(A) $6.4 \times 10^3\ A/m^2$
(B) $5.7 \times 10^3\ A/m^2$
(C) $4.4 \times 10^3\ A/m^2$
(D) $3.2 \times 10^3\ A/m^2$

Resistance and Resistivity

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

$\Omega = V/A$ ← R | V | i

V → Volt "V"

i → A

➢ The SI unit of resistance is the ohm (Ω), 1 Ω = 1 V/A.

Example 2:

A 4 Ω resistor is connected to a potential of 12 V. the current passing through the resistor is:

Solution:

$i = \frac{V}{R} = \frac{12}{4} = \boxed{3A}$

(A) 1 A
(B) 2 A
(C) 3 A ✓
(D) 4 A

The resistivity ρ & the conductivity σ of a material

$$\rho = \frac{E}{J}$$

EF

ρ → Vesistivity → $\Omega.m$

J → Current denisty

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

σ → Conductivity → $\{\Omega.m\}^{-1}$

ρ → Vesistivity

Calculating Resistance from Resistivity

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

R → Vesistance, ρ → Vesistivity, L → length, A → Area

Example 3:

A wire of length 5 cm and cross-sectional area 2 mm² is connected to a potential of 12 V. If the current passing through the wire is 2 A, the resistivity of the wire is:

Solution:

$R = \rho\frac{L}{A}$ ($L \to 5\,cm$, $A \to 2$) ∴ $\rho = 240$

$\rho \simeq 2.4\times10^{-4}\,\Omega.m$

$J = \frac{i}{A} = \frac{2}{2}$

$J = 15.92\times10^{6}$

$R = \frac{V}{i} = \frac{12}{2}$

$R = 6$

(A) 1.7 × 10⁻⁴ Ω.m
(B) 2.4 × 10⁻⁴ Ω.m ✓
(C) 3.5 × 10⁻⁴ Ω.m
(D) 4.2 × 10⁻⁴ Ω.m

Example 4:

The electric field inside a cylindrical wire of radius 1.2 mm is 0.1 V/m. If the current in the wire is measured to be 16 A, the conductivity of the wire is:

Solution:

$J = \frac{i}{A} = 3.54\times10^{6}$ $\quad \rho = \frac{E}{J} = 2.82\times10^{-8}$

$\sigma = \frac{1}{2.82\times10^{-8}}$

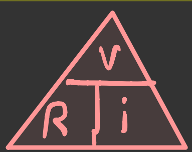
(A) 1.72 × 10⁷ (Ω.m)⁻¹
(B) 2.43 × 10⁷ (Ω.m)⁻¹
(C) 3.54 × 10⁷ (Ω.m)⁻¹
(D) 4.27 × 10⁷ (Ω.m)⁻¹

$= 35.46\times10^{6}$

$\sigma \simeq 3.58\times10^{7}\,\Omega.m$

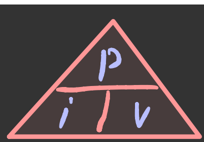
Ohm's Law

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



Power in Electric Circuits

$$P = iV$$



$$P = i^2R \qquad P = \frac{V^2}{R}$$

The unit of power is Watt, (W): 1 W = 1 V. A

Example 5:

The power for the dissipation through a 5 Ω resistor is 3.2 W. The potential difference across the resistor is:

R P V

Solution:

$P = \frac{V^2}{R}$

$3.2 = \frac{V^2}{5}$ $\quad \boxed{V = 4V}$

(A) 1 V
(B) 2 V
(C) 3 V
(D) 4 V ✓