Answer on Question #51508, Physics, Electromagnetism

1. A battery charger supplies 10 A to charge a storage battery which has an open - circuit voltage of 5.6 V. If the voltmeter connected across the charger reads 6.8V, what is the internal resistance of the battery at this time?

2. A nichrome wire is 1.0m long and 1.0mm 2 in cross-sectional area. It carries a current of 4.0 A when a potential difference of 2 V is applied between its ends. Calculate the conductivity of the wire.

3. The current I in a conductor as a function of time t is given as I(t)=5t 2 −3t+10 where current is in ampres A and t is in seconds s. What quantity of charge moves across a section through the conductor during the interval t=2s to t=5s?

4.The current I in a conductor as a function of time t is given as
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Answer:

1) Now, real batteries are constructed from materials which possess non-zero resistivities. It follows that real batteries are not just pure voltage sources. They also possess internal resistances. Incidentally, a pure voltage source is usually referred to as an emf (which stands for electromotive force). Of course, emf is measured in units of volts. A battery can be modeled as an emf connected in series with a resistor, which represents its internal resistance. In our case:

$E = 6.8\ V$

$U = 5.6\ V$

The voltage U of the battery is related to its emf E and internal resistance r via

$U = E - I \cdot r$

$U_{bat} = E - U$

$r = \frac{E-U}{I}$

$$r = \frac{6.8 - 5.6}{10} = \frac{1.2}{10} = 0.12\ Ohm$$

2) Electrical conductivity or electrical conductance has a measure of how an electrical current moves within a substance. The higher the conductivity, the greater the current density for a given applied potential difference.

The electrical conductivity or electrical conductance of a substance is a measure of the its ability to conduct electricity.

The conductivity is important because some substances are required to conduct electricity as well as possible, i.e. in the case of wire conductors, whereas others are used as insulators, and other substances may be required to conduct less electricity, acting as a resistor.

Resistivity and conductivity are interrelated. Conductivity is the inverse of resistivity. Accordingly it is easy to express one in terms of the other.

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

It is possible to relate the conductivity to the resistance, length and cross sectional area of the specimen.

$R = \frac{\rho S}{l}$.

From Ohm's law:

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

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

$$\frac{\rho S}{l} = \frac{U}{I}$$

$$\rho = l \cdot \frac{U}{I} \cdot S$$

$$\rho = \frac{1\, m \ \cdot 2\, V}{4\, A \cdot 1 \cdot 10^{-6}\, m^2} = 0.5 \cdot 10^6\, Ohm \cdot m$$

$$\sigma = \frac{1}{0.5 \cdot 10^6} = 2 \cdot 10^{-6}\, S \cdot m^{-1}$$

3) If the two requirements of an electric circuit are met, then charge will flow through the external circuit. It is said that there is a current - a flow of charge. Using the word current in this context is to simply use it to say that something is happening in the wires - charge is moving. Yet current is a physical quantity that can be measured and expressed numerically. As a physical quantity, current is the rate at which charge flows past a point on a circuit. As depicted in the diagram below, the current in a circuit can be determined if the quantity of charge Q passing through a cross section of a wire in a time t can be measured. The current is simply the ratio of the quantity of charge and time.

$$I(t) = \frac{dq}{dt}$$

$$dq = I(t)dt$$

$$I(t) = 5t^2 - 3t + 10$$

$$\int_0^q dq = \int_2^5 (5t^2 - 3t + 10)dt = \frac{5t^3}{3} - \frac{3t^2}{2} + 10t\, \begin{matrix} 5 \\ 2 \end{matrix}$$

$$q = 193.5\, C$$

4) Almost the same solution as for third task.