

Answer on Question 75069, Physics, Electric Circuits

Question:

A fuse in an electric circuit is a wire that is designed to melt, and thereby open the circuit, if the current exceeds a predetermined value. Suppose that the material to be used in a fuse melts when the current density rises to 390 A/cm^2 . What diameter of cylindrical wire should be used to make a fuse that will limit the current to 0.66 A ?

Solution:

By the definition of the current density we have:

$$J = \frac{I}{A} = \frac{I}{\frac{\pi d^2}{4}} = \frac{4I}{\pi d^2},$$

here, I is the current flowing through the wire, A is the cross-sectional area of the wire, d is the diameter of the wire.

From this formula we can find the diameter of the wire that should be used to make a fuse that will limit the current to 0.66 A :

$$d = \sqrt{\frac{4I}{\pi J}} = \sqrt{\frac{4 \cdot 0.66 \text{ A}}{\pi \cdot 390 \frac{\text{A}}{\text{cm}^2} \cdot \left(\frac{100 \text{ cm}}{1 \text{ m}}\right)^2}} = 4.6 \cdot 10^{-4} \text{ m}.$$

Answer:

$$d = 4.6 \cdot 10^{-4} \text{ m}.$$

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