391.

Problem 32.33 (RHK)

When 115 V *is applied across a* 9.66-m-*long wire, the current density is* 1.42 A cm^{-2}. *We have to calculate the conductivity of the wire material.*

Solution:

We will assume that the electric field is uniform in the wire. As the potential difference across the ends of a wire of length 9.66 m is 115 V, the electric field in the wire will be

$$E = \frac{V}{l} = \frac{115}{9.66} \text{ V m}^{-1} = 11.90 \text{ V m}^{-1}.$$

The current density, j, and electric field, E, are related as

$$j = \sigma E,$$

where σ is the conductivity of the material. The current density in the wire is $1.42 \text{ A cm}^{-2} = 1.42 \times 10^4 \text{ A m}^{-2}$.

Therefore, conductivity of its material will be

$$\sigma = \frac{j}{E} = \frac{1.42 \times 10^4}{11.9} \left(\Omega \text{ m}\right)^{-1} = 1190 \left(\Omega \text{ m}\right)^{-1}.$$