Answer on Question #43941 – Physics – Other

Question.

In an experiment 2 determine d resistivity of a wire, d following measurements were obtained resistance=2.5+ or - 0.01 ohms, length=65.0+ or -0.1cm,diameter=0.5+ or-0.01mm given dat resistivity is RA/L calculate i. d value of resistivity ii. d absolute uncertainty in d resistivity value iii.write d final result with d error.

Given:

$R \pm dR = 2.5 \pm 0.01\ Ohms$

$L \pm dL = 65 \pm 0.1\ cm = 0.65 \pm 0.001\ m$

$D \pm dD = 0.5 \pm 0.01\ mm$

Find:

1) $\rho = ?$
2) $d\rho = ?$
3) $\rho + d\rho = ?$

Solution.

From the given formula resistivity is:

$$\rho = \frac{RA}{L},$$

where $A = \frac{\pi D^2}{4}$ is the cross-sectional area of a wire.

So,

$$\rho = \frac{RA}{L} = \frac{\pi D^2 R}{4L}$$

By first method absolute uncertainty is:

$$d\rho = \frac{\pi (dD)^2 dR}{4dL}$$

1) Calculate:
$$\rho = \frac{\pi D^2 R}{4L} = \frac{3.14 \cdot 0.5^2 \cdot 2.5}{4 \cdot 0.65} = 0.7548\ \frac{Ohm \cdot mm^2}{m}$$
2) Calculate:

$$d\rho = \frac{\pi(dD)^2 dR}{4dL} = \frac{3.14 \cdot 0.01^2 \cdot 0.01}{4 \cdot 0.001} = 0.0008 \ \frac{Ohm \cdot mm^2}{m}$$

3)

$$\rho \pm d\rho = 0.7548 \pm 0.0008 \ \frac{Ohm \cdot mm^2}{m}$$

It means $\rho \in [0.754; 0.7556]$

But this method doesn't consider the signs of errors. That's why, let use the second method:

1) Calculate:

$$\rho = \frac{\pi D^2 R}{4L} = \frac{3.14 \cdot 0.5^2 \cdot 2.5}{4 \cdot 0.65} = 0.7548 \ \frac{Ohm \cdot mm^2}{m}$$

2) Calculate:

$$\rho - d\rho = \frac{\pi(D - dD)^2(R - dR)}{4(L - dL)} = \frac{3.14 \cdot (0.5 - 0.01)^2 \cdot (2.5 - 0.01)}{4 \cdot (0.65 - 0.001)} =$$

$$= 0.7231 \ \frac{Ohm \cdot mm^2}{m}$$

$$\rho + d\rho = \frac{\pi(D + dD)^2(R + dR)}{4(L + dL)} = \frac{3.14 \cdot (0.5 + 0.01)^2 \cdot (2.5 + 0.01)}{4 \cdot (0.65 + 0.001)} =$$

$$= 0.7871 \ \frac{Ohm \cdot mm^2}{m}$$

$$d\rho = \frac{1}{2}[(\rho + d\rho) - (\rho - d\rho)] = \frac{1}{2}(0.7871 - 0.7231) = 0.032 \ \frac{Ohm \cdot mm^2}{m}$$

3)

$$\rho \pm d\rho = 0.7548 \pm 0.032 \ \frac{Ohm \cdot mm^2}{m}$$

It means $\rho \in [0.7228; 0.7866]$

Answer.

1)

$$\rho = 0.7548 \ \frac{Ohm \cdot mm^2}{m}$$

2)

$$d\rho = 0.032 \ \frac{Ohm \cdot mm^2}{m}$$

3)

$$\rho \pm d\rho = 0.7548 \pm 0.032 \ \frac{Ohm \cdot mm^2}{m}$$