

PROBLEM ONE: (20 points)

A) (10 points) What is the relationship between the resistance R and resistivity ρ of a wire of diameter d and length L ? (Express your answer in terms of d, L, ρ please.)

write down $R = \frac{L}{A} \rho$ (or its equivalent) only, 5 points

$R = \frac{L}{(\frac{d}{2})^2 \pi} \rho$ or its equivalent, 10 points

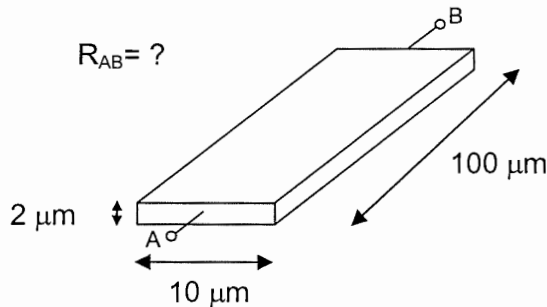
B) (10 points) Calculate the resistance of a copper wire that is 100 feet long and 3 mm in diameter. Express your answer in units of Ω . Get your answer right to within 10%. Assume the resistivity of copper is $10 \mu\Omega\text{-cm}$.

write down (1) $R = \frac{L}{(\frac{d}{2})^2 \pi} \rho$ or its equivalent only 1 pts

write down eqn. (1) and write in values correctly only
5 pts

get correct answer (0.387 - 0.474 Ω)
10 pts

PROBLEM TWO: (40 points)



A new semiconductor is discovered. Scientists find that the mobility of electrons is approximately $20,000 \text{ cm}^2/\text{V}\cdot\text{s}$, and that the effective mass of electrons is equal to the free electron mass.

A) (20 points)

The material is doped n-type so that $n = 10^{18} \text{ cm}^{-3}$.

Find the resistivity ρ of the semiconductor to within 10% in units of $\mu\Omega\cdot\text{cm}$.

Write $\rho = \frac{1}{q\mu n}$ only, 5 points Write $\rho = \frac{1}{q\mu n}$ only, 3 points.

Write eqn (2) and insert correct values, 10 points.

Correct answer (279-341 $\mu\Omega\cdot\text{cm}$) 20 points.

B) (20 points)

Correct answer (not $\mu\Omega\cdot\text{cm}$), 15 points.

For this hypothetical semiconductor, what is the average time between scattering events τ ?

Write OR WRITE $\rho = \frac{m}{nq^2\tau}$

(3) $\mu = \frac{q\tau}{m}$ 5 points.

Write eqn 3, insert correct values, 10 points.

Correct answer (10.2 - 12.6 ps) 20 points.

ONLY IF CALCULATED CORRECTLY.

PROBLEM THREE (40 points):

The two figures below represent two different Si wafers at 300 K.

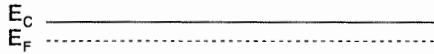


Figure 1

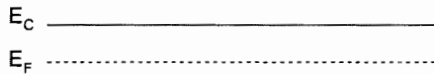


Figure 2

- A) (10 points) For figure 1, which is larger: n or p?
- B) (10 points) For figure 2, which is larger, n or p?
- C) (10 points) Is n for figure 1 larger than n for figure 2?
- D) (10 points) Is p for figure 1 larger than p for figure 2?

All or nothing
for each
part.