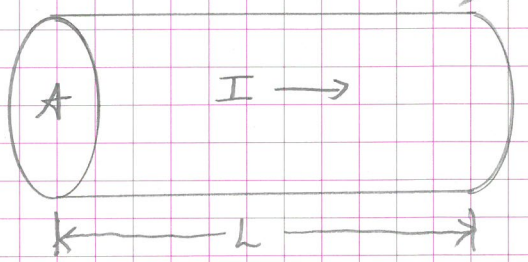
13.40) CONSIDER A CYLINDRICAL RESISTOR. SHOW THAT $V = IR$ IS EQUIVALENT TO $\vec{E} = \vec{J}\rho$ WHERE $R = \rho L/A$.

$\vec{E}$ = ELECTRIC FIELD



FOR A CYLINDRICAL RESISTOR, OHM'S LAW APPLIES

$$V = IR \qquad (1)$$

AND

$$R = \frac{\rho L}{A} \qquad (2)$$

THE VOLTAGE ACROSS THE RESISTOR IS THE E-FIELD TIMES THE LENGTH

$$V = EL \qquad (3)$$

PUTTING THIS TOGETHER WITH (1) AND (2),

$$EL = I\left(\frac{\rho L}{A}\right)$$

$$E = \rho \frac{I}{A}$$

SINCE THE CURRENT DENSITY IS THE CURRENT DIVIDED BY THE AREA

$$J = \frac{I}{A}$$

THUS

$$\boxed{E = J\rho} \rightarrow \text{EQUIVALENT TO OHM'S LAW!}$$