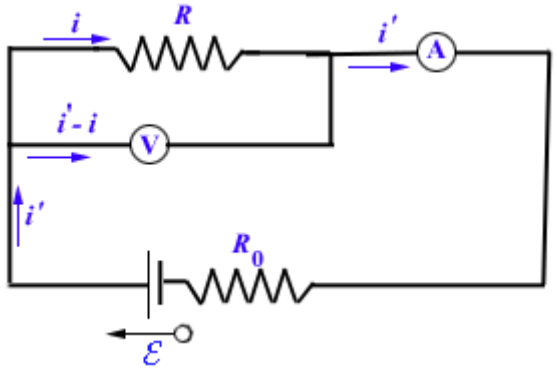
418.

Problem 33.43 (RHK)

A voltmeter resistance R_V *and an ammeter resistance* R_A *are connected to measure a resistance R, using a circuit as shown in the figure. The resistance is given by* $R = V/i$, *where V is the voltmeter reading and i is the current in the resistor R. Some of the current registered by the ammeter* (i') *goes through the voltmeter so that the ratio of the meter readings* $(= V/i')$ *gives only an apparent resistance reading* R'. *We have to show that R and* R' *are related by*

$$\frac{1}{R} = \frac{1}{R'} - \frac{1}{R_V}.$$

Note that as $R_V \to \infty$, $R' \to R$.



Solution:

Let the resistance of the voltmeter be R_V. As the voltmeter is connected in parallel with the resistance R, currents $i' - i$ flowing through the voltmeter and i flowing through the resistance R are related as

$$(i' - i)R_V = iR,$$

or

$$i(R + R_V) = i'R_V.$$

The measured resistance

$$R' = \frac{V}{i'}.$$

Therefore, we have

$$\frac{i(R + R_V)}{V} = \frac{i'R_V}{V},$$

or

$$\frac{(R + R_V)}{R} = \frac{R_V}{R'},$$

or

$$\frac{1}{R} = \frac{1}{R'} - \frac{1}{R_V}.$$

We note that as $R_V \to \infty,\ R' \to R.$