Answer on Question #77502, Physics / Electric Circuits

Question. A filament lamp is placed with a resistor of 150 ohms as shown in the circuit below and then connected to a cell of potential difference 12 volts . The current leaving the cell is $0.1\ A$. Calculate the resistance of the filament lamp.

Given. $R = 150\ \Omega;\ U = 12\ V;\ I = 0.1\ A$.

Find. $r-?$

Solution.

Assume that the internal resistance of the cell $R_{in} = 0$.

In case of parallel connection

We have

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{r} \quad \rightarrow \quad R_p = \frac{R \cdot r}{R + r}$$

$$I = \frac{U}{R_p} = \frac{U(R + r)}{R \cdot r} \quad \rightarrow \quad I \cdot R \cdot r = U(R + r) \quad \rightarrow \quad I \cdot R \cdot r - U \cdot r = U \cdot R \quad \rightarrow$$

$$r(I \cdot R - U) = U \cdot R \quad \rightarrow \quad r = \frac{U \cdot R}{I \cdot R - U} = \frac{12 \cdot 150}{0.1 \cdot 150 - 12} = 600\ \Omega$$

In case of serial connection

We have

$$R_s = R + r$$

$$I = \frac{U}{R + r} \quad \rightarrow \quad I \cdot R + I \cdot r = U \quad \rightarrow \quad r = \frac{U - I \cdot R}{I} = \frac{12 - 0.1 \cdot 150}{0.1} = -30\ \Omega$$

The solution has no meaning.

So, we have a parallel connection.

Answer. $r = \frac{U \cdot R}{I \cdot R - U} = 600\ \Omega$.