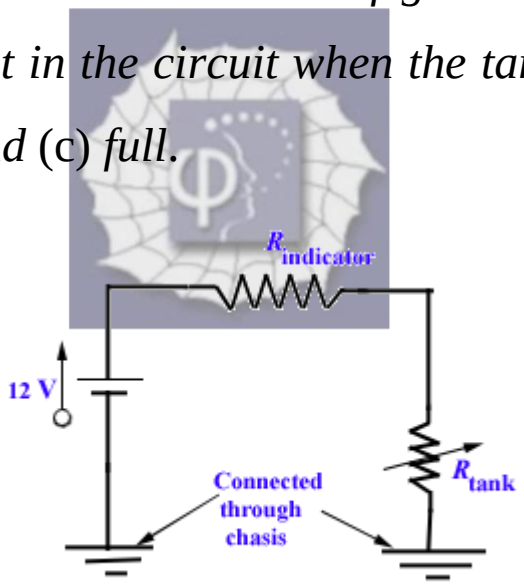
402.

Problem 33.6 (RHK)

A gasoline gauge for an automobile is shown schematically in the figure. The indicator (on the dashboard) has a resistance of $10\ \Omega$. *The tank is simply a float connected to a resistor that has a resistance of* $140\ \Omega$ *when the tank is empty,* $20\ \Omega$ *when it is full, and varies linearly with the volume of gasoline. We have to find the current in the circuit when the tank is* (a) *empty,* (b) *half full, and* (c) *full.*



Solution:

We note the data of the problem:

$E \equiv 12\ V,$

$R_{indicator} = 10\ \Omega,$

$R_{tank}\left(\text{empty}\right) = 140\ \Omega,$

$R_{\text{tank}}\left(\text{full}\right) = 20\ \Omega.$

We will apply Ohm's law in finding the current in the circuit with different total resistances.

(a)

Resistance in the circuit when the tank is empty will be $R = \left(140 + 10\right)\ \Omega = 150\ \Omega.$ Current in the circuit when the tank is empty will be

$$i\left(\text{tank empty}\right) = \frac{12}{150}\ \text{A} = 0.08\ \text{A}.$$

(b)

Resistance in the circuit varies linearly with the volume of gas in the tank. Let the volume of the full tank be *V*. From the values of $R_{\text{indicator}} = 10\ \Omega,$ and $R_{\text{tank}}\left(\text{full}\right) = 20\ \Omega$, we note that the linear equation giving the resistance as a function of volume of gas in the tank will be

$$R\left(\Omega\right) = -\frac{120}{V}v + 140.$$

When the tank is half full, the volume of the gas will be $V/2$, and the resistance of the fuel tank will be $R = 80\ \Omega.$ The total resistance in the circuit in this situation will be $R\left(\text{half full}\right) = 90\ \Omega.$

$$i\left(\text{tank half full}\right)=\frac{12}{90}\ \text{A}=0.133\ \text{A}.$$

(c)

When the tank is full the total resistance in the circuit will be

$$R\left(\text{full}\right)=30\ \Omega.$$

And

$$i\left(\text{tank full}\right)=\frac{12}{30}\ \text{A}=0.40\ \text{A}.$$