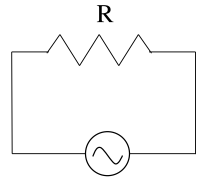
Problem 21.1

a.) A light bulb uses an average power of 75 W. What is its resistance if used in the circuit to the right?



$\varepsilon = 170\sin(377t)$

b.) What is its resistance if the bulb is 100 W?

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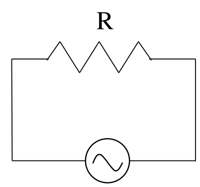


$\varepsilon = 170\sin(377t)$

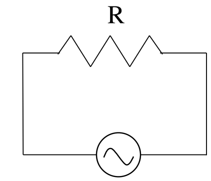
The first thing to notice is the way I have given you the information involved in the problem (the book said it was a 60 Hz power supply with a maximum voltage of 170 volts). This is more akin to what you will see on a test with the amplitude of the voltage function clearly being 170 volts and the frequency term embedded in the $\sin(\omega t) = \sin(2\pi\nu t) = \sin(2\pi(60\text{ Hz})t) = \sin(377t)$ term.

As for the actual problem, in AC circuits the voltage and current values that are used are always RMS values (these are what AC meters read).

The RMS value of the voltage source, which is the same as the voltage across the resistor, is:

$$\begin{aligned} V_{RMS} &= .707V_{max} \\ &= .707(170\text{ V}) \\ &= 120\text{ V} \end{aligned}$$

Note: 120 volts RMS at 60 Hz—we are looking at a wall socket!



$\varepsilon = 170\sin(377t)$

Remembering that $i_{RMS} = \frac{V_{RMS}}{R}$, the power expression can be denoted several ways:

$$\begin{aligned} P &= i_{RMS} \quad V_{RMS} \\ &= \left(\frac{V_{RMS}}{R}\right)V_{RMS} \\ &= \frac{(V_{RMS})^2}{R} \end{aligned}$$

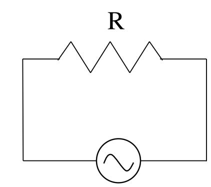
With that, we can write:

$$P = \frac{(V_{RMS})^2}{R}$$

$$\Rightarrow \quad (75\text{ W}) = \frac{(120\text{ V})^2}{R}$$

$$\Rightarrow \quad R = 192\ \Omega$$

b.) If the light bulb requires 100 W:



$\varepsilon = 170\sin(377t)$

$$P = \frac{(V_{RMS})^2}{R}$$

$$\Rightarrow \quad (100\text{ W}) = \frac{(120\text{ V})^2}{R}$$

$$\Rightarrow \quad R = 145\ \Omega$$

THE POINT: These problems are not at all unlike DC circuit problems. The only difference is that the voltages and currents are the RMS values of the AC voltages and currents. This is NO BIG DEAL!