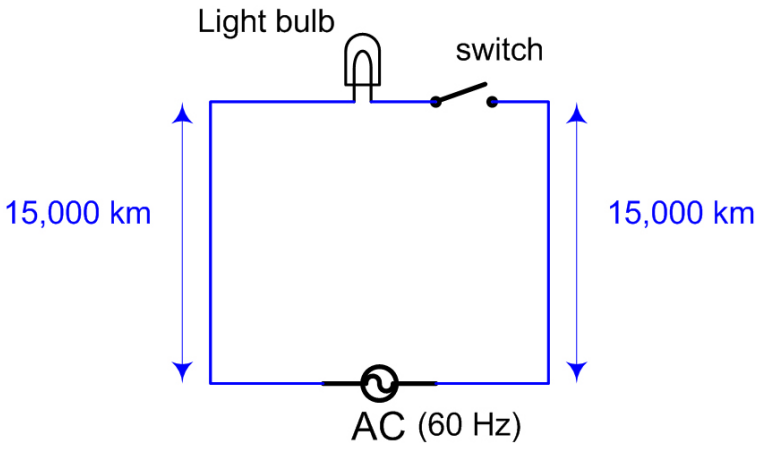
Electricity problem – Alternative Current

The speed of the electromagnetic field in a circuit (through the wires) is close to the speed of light $c = 300000 \, \frac{km}{sec}$.

The AC frequency in North America is $f = 60\,Hz$, therefore the distance covered by the electromagnetic field in one cycle is:

$$d_{60} = v \cdot t = c \cdot \frac{1}{60} \, sec = 300,000 \, \frac{km}{sec} \cdot \frac{1}{60} \, sec = \frac{300,000}{60} \, km = 5,000 \, km \, .$$

Imagine the following circuit, with very long conductors on both sides (the length is measured from the ends of the bulb to the AC source, it includes the length of the switch itself and of the connecting wire between the light bulb and the switch):



We neglect all losses in the long wires, therefore we treat this as an ideal circuit.

What happens when we close the switch? Justify your answer. Compute whatever results are required (if that is the case).

a) the bulb lights up instantaneously.

b) the bulb never lights up.

c) the bulb lights up with a time delay from the moment the switch is closed (compute the time delay if that is the case).