Magnetic Field

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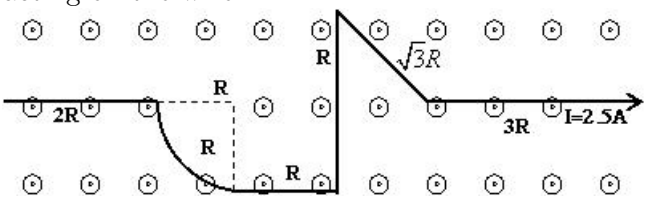
The problem:

The wire on the picture carries current of 2.5 A. The wire is curved in the $x-y$ plane. In the perpendicular direction to this plane ($\hat{z}$) there is a magnetic field of 0.005 T. What is the force acting on the wire?



The solution:

The force on a directed wire of a length $\vec{L}$ is

$$\vec{F} = I\vec{L} \times \vec{B} \tag{1}$$

In our case we have several pieces of wires connected together with the same current and in the same magnetic field. Then the total force on the wires is

$$\sum_i \vec{F_i} = \sum_i I_i \vec{L_i} \times \vec{B_i} = I\left(\sum_i \vec{L_i}\right) \times \vec{B} = I\vec{L_T} \times \vec{B} \tag{2}$$

The total length is

$$\vec{L_T} = \sum_i \vec{L_i} = (7+\sqrt{2})R\hat{x} \tag{3}$$

Therefore,

$$\vec{F} = I\vec{L_T} \times \vec{B} = -I|L_T||B|\hat{y} = -0.11\hat{y}\ N \tag{4}$$