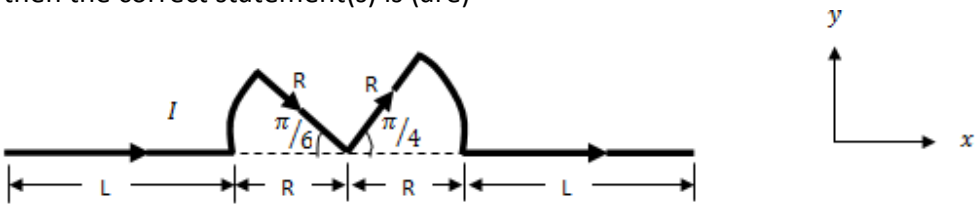
15. A conductor (shown in the figure) carrying constant current *I* is kept in the $x-y$ plane in a uniform magnetic field $\vec{B}$. If F is the magnitude of the total magnetic force acting on the conductor, then the correct statement(s) is (are)



(A) If $\vec{B}$ is along $\hat{z}$, $F \propto (L+R)$

(B) If $\vec{B}$ is along $\hat{x}$, $F = 0$

(B) If $\vec{B}$ is along $\hat{y}$, $F \propto (L+R)$

(D) If $\vec{B}$ is along $\hat{z}$, $F = 0$

Answer:

Here total length of the conductor = L+R+R+L=2L+2R=2(L+R)

We know force experienced by a current carrying conductor in magnetic field: $\vec{F} = i(\vec{dl} \times \vec{B})$

Direction of force can be obtained using cross product rule.

[Refer for details http://selfstudy.in/HSEPhysics/MechanicalForceOnConductor.pdf]

Choice (A) if $\vec{B}$ is along Z axis then since it is at right angle to the current element force will be experienced and magnitude of the force will be proportional to the total length $F \propto (L+R)$. This option is correct.

Choice (B) if $\vec{B}$ is along x axis then $\vec{dl}$ and $\vec{B}$ are parallel, angle 0^0 hence no force will be experienced F=0, this option is also correct.

Choice (C) if $\vec{B}$ is along y axis, it is at right angle to the current element $\vec{dl}$ which is along x-axis hence force will be experienced and force will be proportional to the total length $F \propto (L+R)$. This option is also correct.

Choice (D) if $\vec{B}$ is along z axis, since it is at right angle to the current carrying conductor force will be experienced and $F \propto (L+R)$ as in choice (A) but magnitude $F \neq 0$ hence this option is false.

Correct options are (A),(B) and (C)