How to approach the problem

Identify / Setup

Type: Force on a current element

Knowledge domain:

Straight conductor of length $L$ carrying a current $I$ in a uniform $B$-field of strength $B$ will experience a force $F_B$.

$$F_B = BIL \sin \theta$$

$\theta$ is the angle between the conductor (current) and the direction of the $B$-field

The direction of the force is determined by the right hand palm rule

$$\vec{v}(+q) \quad \overrightarrow{I} \quad \vec{F}$$

Execute/Evaluate

(1)

The angle between the current element and the magnetic field is

$$\theta = 90^\circ \implies \sin 90^\circ$$

The magnitude of the force on the current element is

$$F_i = BIL$$

From the right hand palm rule, the direction of the force is always at right angles to the current element and varies as the rod rotates. The direction of the force is always in the plane of the page (xy plane).
(2)
The angle between the current element continually changes as the rod rotates and the magnitude of the force on the current element is

\[ F_2 = BIL \sin \theta \]

magnitude varies with angle

From the right hand palm rule, the direction of the force is always at right angles to the current element and therefore, always direction in the \(-z\) direction (into page).

Note: \( F_1 \geq F_2 \)

This problem is based on a multiple choice question from HSC Physics 2001 (Q14). Even for multiple choice questions, you should use the how to approach the problem method.