☹ em-que-07013

A circular coil is formed from a wire of length L with n turns. The coil carries a current I and is placed in an external uniform magnetic field B. Show that maximum torque developed is $\dfrac{IBL^2}{4n\pi}$.

☺ Solution:

The circumference of the coil $= L/n$
The radius of the coil $(a) = L/(2\pi n)$
Area of the loop $= \pi \times a^2 = L^2/(4\pi n^2)$
The magnetic moment due to one turn = current $\times$ area $= IL^2/(4\pi n^2)$
The coil has n turns so magnetic moment $= n \times IL^2/(4\pi n^2) = IL^2/(4\pi n)$.
Let θ be the angle between the normal to the coil and the magnetic field.
The total torque $= mB\cos\theta = (IBL^2\cos\theta)/(4\pi n)$
The torque will be maximum when $\cos\theta = 1$.
Thus maximum torque is $= \dfrac{IBL^2\cos\theta}{4\pi n}$.

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Halliday- Resnick*