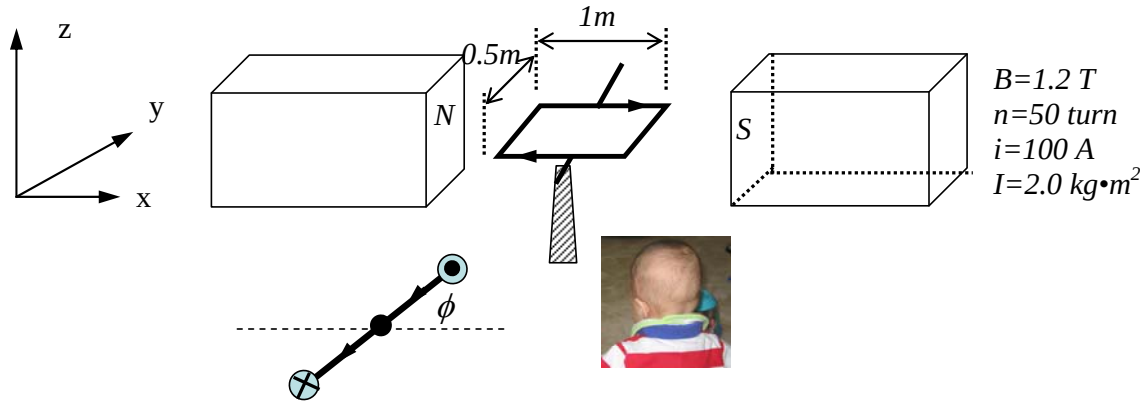
Discussion 8C
P212, Week 8
Small babies, huge magnets, and dangerous currents

A current loop that is 1m long and 0.5 m wide carries a current of 100 A and has 50 turns. It is pivoted to turn frictionlessly on an axle along the y-axis. The second pivot support is not drawn. The coil is bathed in a magnetic field of 1.2 T that points either parallel or anti-parallel to the x-axis (you decide from the figure). The moment of inertia of the coil about this pivot is $I=2\ kg\bullet m^2$. The baby-eye view of the coil orientation is shown to the left of the baby. Initially $\phi = 0^0$ meaning the coil is in the x-y plane.



a) Find the initial forces on each of the 4 sides of the coil when it lies in the x-y plane as shown. Specify their magnitude and direction.

b) Find the direction and magnitude of the magnetic moment $\vec{\mu}$ when the coil is in the x-y plane in terms of components.

c) Find the torque on the coil when it is in the x-y plane. Specify the direction of the torque. Is it consistent with your answers to part a)?

d) The baby tries to hold the coil in the x-y plane and prevent it from turning. Can he do it? Can his father do it? Can King-Kong do it? Calculate the force required to hold the coil in the x-y plane if the force is applied on the coil side that is closest to the south pole of the magnet.

e) Find the components of $\vec{\mu}$ when the coil is inclined at an angle ϕ.

f) King-Kong releases the coil (from rest) and it begins to turn. Does ϕ increase or decrease? Describe the motion in terms of $\omega = \frac{d\phi}{dt}$ as a function of ϕ. What ϕ range does the coil motion cover? At what ϕ is ω the largest? Use the convention that $0 \le \phi \le 360^0$. Recall that the kinetic energy of a rotating object is $KE = \frac{1}{2} I\omega^2$.

g) Find the maximum value of ω that the coil achieves.

h) Find the maximum speed of the coil segment that lies along the + y axis after the coil is released.