

Written question

One day, down at Sally's So-So Inventions, Sally decides to invent a really-not-that-useful automatic spaghetti fork that spins around on its own to help the (most-likely-slightly-embarrassed) user twirl their spaghetti. The device includes a solenoid with 500 turns in 3 cm which carries a current of 0.1A. Inside the solenoid is loop of wire wound 50 times into a 1cm by 1cm square, which is connected to a fork. The unit is designed so that current through the square loop (also 0.1A) reverses direction twice per spin, so that the torque on the loop is always in the same direction. Suppose the square loop begins parallel to the field in the solenoid, and suppose that the moment of inertia of the square loop plus fork is 10^{-6} kg m^2 . How long does it take for the fork to spin around one full turn without any spaghetti on it, starting from an initial state with zero angular velocity. Assume that friction is negligible.

(Hint: what is the torque on the fork when the square loop is at an angle of θ relative to the field?)

