

M04E.3—Penny Thrown into a Solenoid

Problem

A penny is thrown towards a large solenoid magnet. The penny moves along the axis of the solenoid with a frictionless constraint which keeps the plane of the penny perpendicular to the solenoid axis. As the penny approaches the solenoid, eddy currents are induced in it and result in a repulsive force which slows its motion. Estimate the minimal initial velocity which is needed in order for the penny to reach the entrance of the long solenoid magnet, with internal field of $B = 1$ T and diameter $D = 0.1$ m. You may ignore gravity and take the mass density and resistivity of copper to be $\rho \approx 10^4$ kg/m³ and $\rho_R \approx 10^{-6}$ Ohm m, respectively.