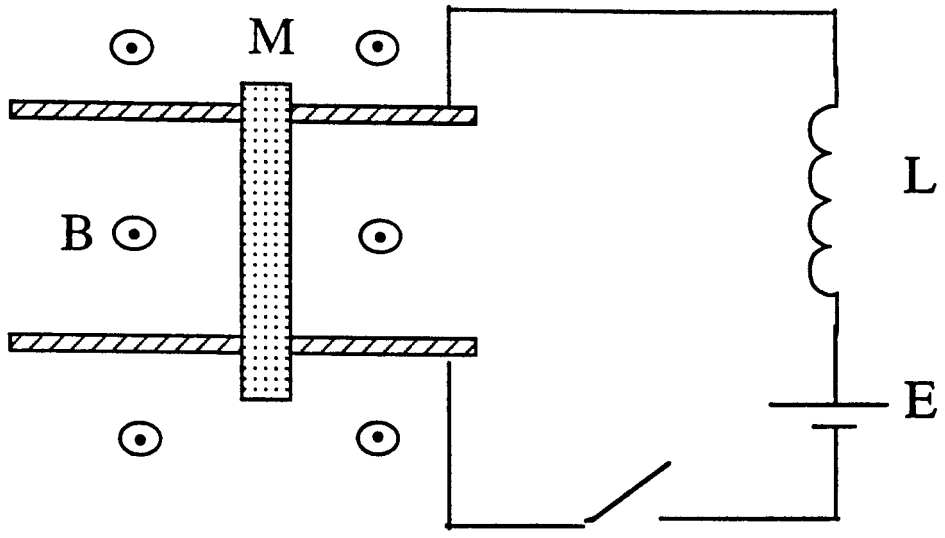
EM7a/197B



A conducting rod of mass M is free to slide without friction on two long parallel conducting rails separated by a distance D. The rails are connected through a switch to a battery of emf E and a coil of inductance L. The rod completes the circuit. There is negligible electrical resistance. A uniform magnetic field B is normal to the plane of the paper, as shown.

(a) Assuming the switch to be closed, show that the speed v of the rod as a function of time t satisfies a differential equation of the form

$$d^2v/dt^2 + av + b = 0$$

Find expressions for a and b in terms of the quantities E, D, L, B, M, and fundamental constants.

(b) Now suppose the switch, which is initally open, is closed at t=0 and that I(0)=v(0)=0. Sketch the potential drop across both the inductor and the rod as a function of time. Be sure to include both a voltage and time scale.

(c) Find I(t) for t>0.