M01M.3—Particle in Gravitational and Magnetic Fields

Problem

A particle of mass m and charge q moves freely in a gravitational field $\boldsymbol{g} = g\hat{j}$ and a magnetic field $\boldsymbol{B} = B\hat{k}$. At time $t = 0$ the particle is released from the origin O with no initial velocity. It traces a curve in the x-y plane.

a)   Find the parametric equations $x = x(t), y = y(t)$ describing the curve. Sketch the curve on an x-y diagram.

The above motion is idealized, because two effects have been ignored: air drag and radiation damping.

b)   Now assume that the particle also feels a drag force due to the surrounding atmosphere, $F = -\beta v$. Derive the motion of the particle. What is its final velocity?

c)   Instead of air drag, suppose we include the damping effect caused by the electromagnetic radiation emitted during its motion. Describe, qualitatively, how this modifies the motion found in part a). What is the final velocity of the particle?