Section B. Electricity and Magnetism

1. A small wire loop of radius a lies in the xy-plane, centered on the origin. A magnetic moment $\mathbf{m} = m\,\hat{\mathbf{z}}$ travels up along the z axis with constant speed v. It passes through the center of the wire loop at $t = 0$.

   (a) Compute the emf $\mathcal{E}(t)$ around the loop.
   Hint: the integral is easier if you evaluate the flux through a section of a spherical surface centered on the magnet and bounded by the wire loop rather than through the planar area bounded by the loop.

   (b) If the loop has resistance R, find the Joule heat $P(t)$ Assume the loop is fixed in position.

   (c) Now consider the case where a uniform linear charge density λ is glued to a non-conducting loop (same orientation and radius as above), and the loop is allowed to spin. What is the position of $\mathbf{m}$ at the time the loop attains its largest angular momentum, $\mathbf{L}_{max}$? What is the value of $\mathbf{L}_{max}$? Assume the dipole began its constant-velocity motion at $t = -\infty$, and that the loop was at rest then.