(1) Energy Conservation in Motional EMF (15 points)

A cylindrical resistive material with mass density $\rho_m$ (mass/volume) and conductivity $\sigma$ slides frictionlessly on two parallel conducting rails. The length of the cylinder is $l$ and the cross sectional area is $A$. A uniform magnetic field $B$, pointing into the page fills the entire region. The bar moves to the right, starting with a velocity $v_0$.

(a) What current flows through the circuit, and in what direction?
(b) What is the magnetic force on the rod? In what direction?
(c) Use Newton’s equation to show that velocity of the rod as function of time is

$$v(t) = v_0 e^{-\Gamma t}, \text{ where } \Gamma = \frac{B^2 \sigma}{\rho}$$

(d) The initial kinetic energy was $\frac{1}{2} m v_0^2$. At $t = \infty$ the rod looses all this energy.

Where does it go? Prove that energy is conserved by showing that the total energy that goes into this sink is $\frac{1}{2} m v_0^2$.

(2) Griffiths, Problem 7.48. The Bevatron (10 pts).

(3) Griffiths, Problems 7.53 and 7.54. Transformers (15 pts).