TEST II

Physics 23102 **March 16th 1993**

Instructor: Declan Keane *Student* _____

1. (a) What is the definition of power? (b) What is the expression for the power delivered by an emf device (e.g., a battery) with emf ε to an external load with resistance R, if the internal resistance of the emf device is r? (Be sure to express your answer in terms of ε, R and r). (c) Beginning from this expression, find the condition that R should satisfy for the maximum possible power to be delivered to it from a battery with fixed ε and r.

2. A portable appliance get its power from four 1.5 V batteries, wired in series. The appliance draws 250 mA of current, and the batteries last 15 hours. If each battery costs \$1.99, calculate the cost of electrical energy from these batteries, in units of dollars per kilowatt-hour.

3. For each of the following questions, a one-line sentence or a fully labeled formula is sufficient.
   - (a) Under what circumstances does a charged particle experience a force if it is placed in a magnetic field?
   - (b) What is the formula for the magnitude and direction of this force?
   - (c) Under what circumstances does a length of copper wire experience a force if it is placed in a magnetic field?
   - (d) What is the formula for the magnitude and direction of this force for a short element (length $d\mathbf{L}$) of such a wire?
   - (e) What path does a charged particle follow if it travels with uniform speed in a uniform magnetic field?
   - (f) What is Gauss' law for magnetism?
   - (g) Describe how the resistance of a conductor depends on the shape and the material of the conductor.

4. A battery with emf ε is connected across one end of a long coaxial cable (inner conductor radius r_1 and outer conductor radius r_2), and a resistance R is connected across the cable at the other end. Neglect the resistance of the cable and the internal resistance of the battery. Use Ampère's law to find the field $B(r)$ for $r_1 < r < r_2$, (*i.e.*, the magnetic field between the two coaxial conductors).