PART 1  (2 points)
A uniformly charged insulating sphere has charge $Q$ and radius $a$. It is concentric with a thick uncharged conducting shell of inner radius $b$ and outer radius $c$. Potential is defined to be zero at infinity. What is the potential at the center?

PART 2  (2 points)
A long bar of square cross section $a \times a$ has resistivity $\rho$. Inside the bar is a uniform electric field of magnitude $E$. Find the integral

$$\int_{P_1}^{P_2} \mathbf{B} \cdot d\ell$$

of the magnetic field. Here $P_1$ is on an edge of the bar, and $P_2$ is in the middle of a face of the bar. Give the answer in terms of $E$, $\rho$, $a$, and fundamental constants.

PART 3  (2 points)
An $L$ shaped insulator has total charge $Q$ uniformly distributed on it and has legs of length $a$. Find the magnitude of the electric field vector at the point indicated. Give the answer in term of $Q$, $a$, and fundamental constants.

PART 4  (2 points)
A large ring of radius $R_1$ contains $N_1$ turns of wire with negligible separation, and carries a current $I_1$. At the center of the ring is a small solenoid, of radius $R_2$ and length $L$, with $N_2$ turns of wire carrying current $I_2$. The axis of the solenoid lies in the plane of the large ring. Assume that $R_1 \gg L$ and $R_1 \gg R_2$. What is the magnitude of the torque produced on the large ring by the magnetic field of the solenoid? Give the answer in terms of $R_1$, $N_1$, $I_1$, $R_2$, $N_2$, $I_2$, $L$, and fundamental constants.
PART 5  (2 points)
In the RLC circuit shown, the peak AC emf is 800 V and has a frequency of 10 cycles per second; the resistor is 1 Ω, and the inductor is 0.3 H. The capacitor has two parallel plates with a surface area of $10^2 \text{m}^2$, and a separation of 1 micron. What is the maximum electric field strength between the capacitor plates?

![RLC circuit diagram]

PART 6  (2 points)
A diverging lens and a converging lens each have a focal length of 7 cm. The are placed 20 cm apart and an object with a height of 1 cm is placed on the axis at a distance of $23 \frac{1}{3}$ cm from the converging lens, as shown. What is the size of the image produced by the pair of lenses?

![Lenses diagram]