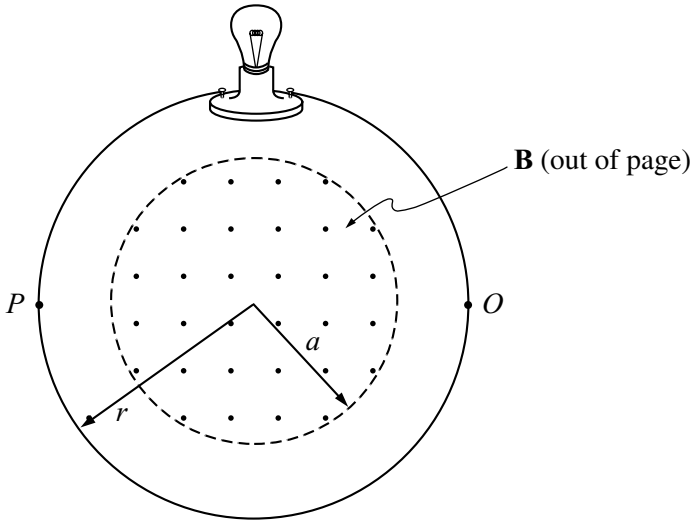
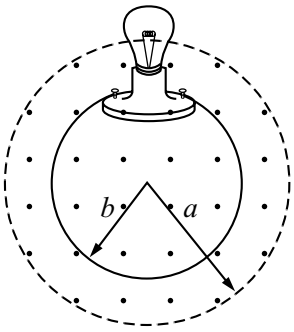


E&M 2. A uniform magnetic field **B** exists in a region of space defined by a circle of radius $a = 0.60$ m as shown above. The magnetic field is perpendicular to the page and increases out of the page at a constant rate of 0.40 T/s. A single circular loop of wire of negligible resistance and radius $r = 0.90$ m is connected to a lightbulb with a resistance $R = 5.0\ \Omega$, and the assembly is placed concentrically around the region of magnetic field.

(a) Determine the emf induced in the loop.

(b) Determine the magnitude of the current in the circuit. On the figure above, indicate the direction of the current in the loop at point O.

(c) Determine the total energy dissipated in the lightbulb during a 15 s interval.



The experiment is repeated with a loop of radius $b = 0.40$ m placed concentrically in the same magnetic field as before. The same lightbulb is connected to the loop, and the magnetic field again increases out of the page at a rate of 0.40 T/s. Neglect any direct effects of the field on the lightbulb itself.

(d) State whether the brightness of the bulb will be greater than, less than, or equal to the brightness of the bulb in part (a). Justify your answer.

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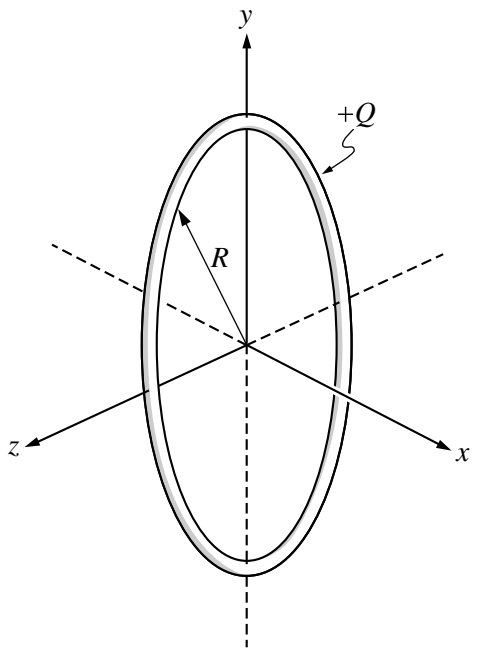

E&M 3. The nonconducting ring of radius R shown above lies in the yz-plane and carries a uniformly distributed positive charge Q.

(a) Determine the electric potential at points along the x-axis as a function of x.

(b) i. Show that the x-component of the electric field along the x-axis is given by

$$E_x = \frac{Qx}{4\pi\epsilon_0 (R^2 + x^2)^{\frac{3}{2}}}.$$

ii. What are the y- and z- components of the electric field along the x-axis?

(c) Determine the following.

i. The value of x for which E_x is a maximum

ii. The maximum electric field $E_{x\,\max}$

E & M 2 (continued)

(d) 3 points

For stating that the brightness of the bulb will be less	1 point
For indicating that the reduction in brightness is due to a decrease in current or a decrease in the emf	1 point
For indicating that the decrease in current or emf, or the reduction in brightness, is due to a decrease in the area of the loop or a decrease in the changing flux	1 point

For using correct units with three numerical answers 1 point