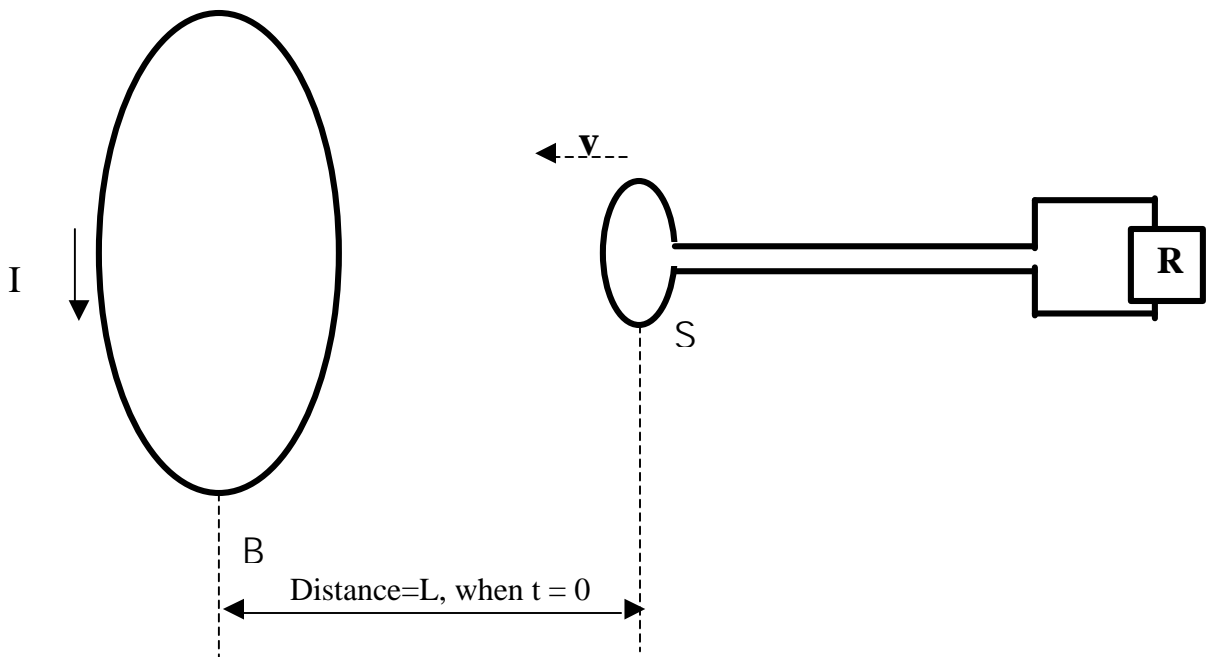


1. Suppose we have two plane waves $\mathbf{E}_1 = \mathbf{A}_1 \exp[j(\omega_1 t - k_1 z)]$ and $\mathbf{E}_2 = \mathbf{A}_2 \exp[j(\omega_2 t - k_2 z)]$ propagating along z in free space. At $t=0$, both waves are at a maximum at $z=0$.
- (a) Find the minimum distance $z=L$ at which the maxima of the two waves coincide again at $t=0$.
- (b) Find the time t when the two plane waves will both be at their maxima at $z = z_0 < L$.
2. In Faraday's experiment, he inserted a permanent magnet into a coil to induce electromotive force. We will approximate his setup with the system shown in the figure below: We have a small circular loop S whose radius is a , connected to a resistor R . It moves with a constant velocity \mathbf{v} towards another circular loop B with a radius b ($b \gg a$), carrying current I . The planes of the two loops are parallel to each other and the line joining their centers is perpendicular to both of them.
- (a) What is the electromotive force $\mathcal{V}(t)$ induced on the loop S as a function of time? (Assume that the magnetic field due to B can be regarded as uniform over the loop S and the current induced in the loop S will be small enough that we can safely ignore the magnetic field it induces.)
- (b) Faraday reported that he experienced an opposing force when he inserted his permanent magnet in the coil. Calculate the force on the loop S as a function of time. (Hint: It is easier if you use an energy argument instead of trying to calculate the force directly.)



3. The electrostatic deflection system of a cathode ray tube is depicted below. An electron (mass m_e) from a heated cathode (not shown) is given an initial velocity $\mathbf{v}_0 = v_0 \mathbf{a}_z$. The electron then enters a region where a uniform electric field is maintained over a width w by two parallel plates a distance d away from each other. Ignoring the gravitational effects,
- (a) What should the applied dc voltage be if we'd like to deflect the electron a distance $y=L$ ($L < d/2$) when it hits the phosphorous screen?
- (b) The voltage across the series resistor R is monitored as a beam of electrons traverse the field between the plates. What do you expect to observe at the voltmeter? Explain or derive.

