Name: _____ Student ID5_____ Session: T ___

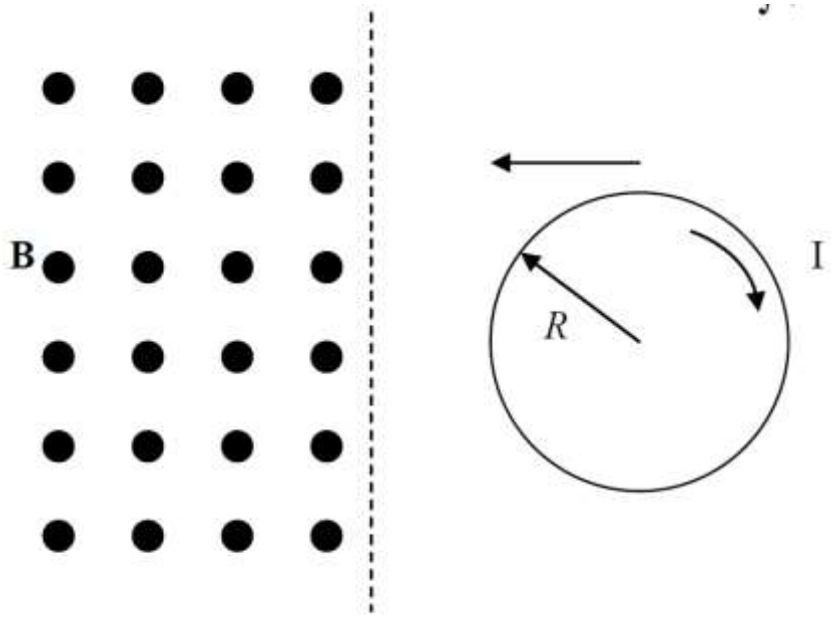
PHYS 3033 - Electricity and Magnetism I

Quiz 10

Time allowed: 15 minutes

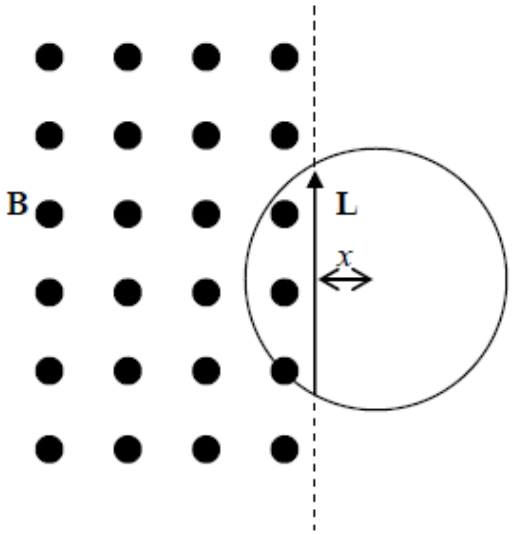
27 Nov 2015

A circular wire of radius *R* carrying current *I* is pushed into a region of uniform magnetic field **B**. The boundary of the region is a plane. Find the work done during this process. Assume that the current in the loop is always constant, and with its plane perpendicular to the field.



Solution:

Consider the moment when the distance of the center of the wire from the boundary of the field is x.



The force acting on the wire is

$$\mathbf{F} = \int (Id\mathbf{l} \times \mathbf{B}) = I\left(\int d\mathbf{l}\right) \times \mathbf{B} = I\mathbf{L} \times \mathbf{B},$$

where **L** is the vector pointing upwards along the boundary, joining the two points of intersection of the wire and the boundary.

The direction of the force is always to the right, with magnitude

$$F = ILB = IB \times 2\sqrt{R^2 - x^2}.$$

Hence the work done is

$$\int_{-R}^{R} 2IB\sqrt{R^2 - x^2}\, dx = IB\pi R^2.$$