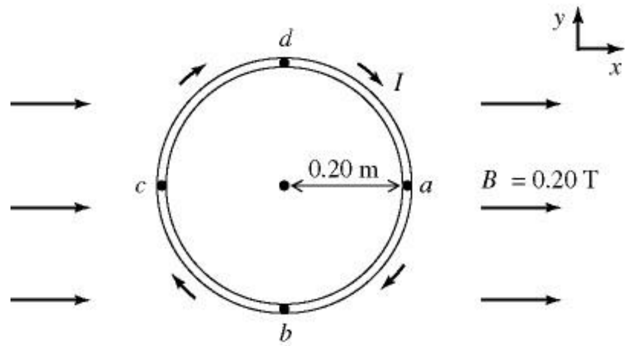
D1

A rigid circular loop has a radius of 0.20 m and is in the *xy*-plane. A clockwise current I=5 A is carried by the loop, as shown. A uniform external magnetic field, B = 0.20 T in the positive x-direction, is present.



What are the torque (value and direction) and magnetic potential energy of this circular loop at this moment?

D2

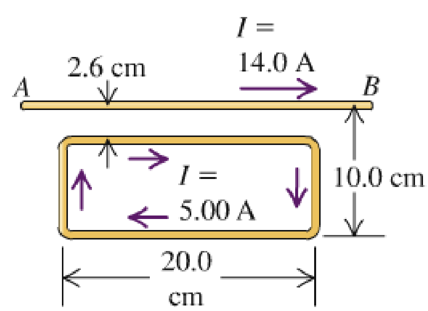
Two identical circular wire loops 48.0 cm in diameter each carry a current of 3.10 A in the same direction. These loops are parallel to each other and are 27.0 cm apart. Line *ab* is normal to the plane of the loops and passes through their centers. A proton is fired at 2,950 m/s perpendicular to line *ab* from a point midway between the centers of the loops.

Find the magnitude of the magnetic force these loops exert on the proton just after it is fired.

D3

The long straight wire *AB* shown in the figure carries a current of 14.0 A. The rectangular loop whose long edges are parallel to the wire carries a current of 5.00 A.

Find the magnitude and direction of the net force exerted on the loop by the magnetic field of the wire.



D4

A long, straight wire with a circular cross section of radius *R* carries a current I. Assume that the current density is not constant across the cross section of the wire, but rather varies as $J = \alpha r$, where α is a constant. (a) By the requirement that J integrated over the cross section of the wire gives the total current I, calculate the constant α in terms of *I* and *R*. (b) Use Ampere's law to calculate the magnetic field $B(r)$ for (i) $r \leq R$ and (ii) $r \geq R$. Express your answers in terms of *I*.