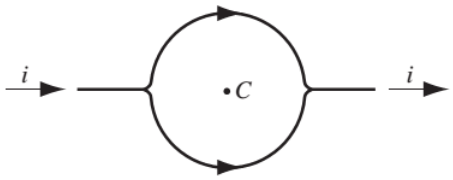
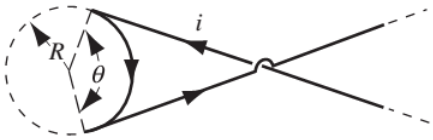
18 Biot-Savart Law

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l}\times\hat{r}}{r^2} \qquad \vec{B} = \frac{\mu_0}{4\pi}\int\frac{I\,d\vec{l}\times\vec{r}}{r^3} \qquad B_{loop,axis} = \frac{\mu_0 I R^2}{2(R^2+z^2)^{3/2}}$$

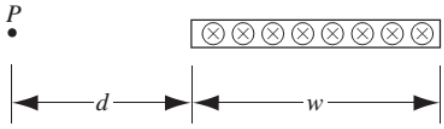
1. *(RHK Exercise 33.6)* A straight conductor carrying a current I is split into identical semicircular turns as shown below. What is the magnetic field strength at the center C of the circular loop so formed?



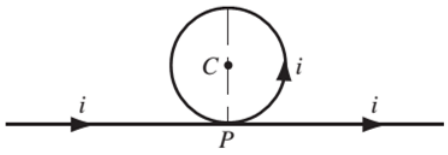
2. *(RHK Exercise 33.12)* A wire carrying current I has the configurations shown below. Two semi-infinite straight sections, each tangent to the same circle, are connected by a circular arc, of angle θ, along the circumference of the circle, with all sections lying in the same plane. What must θ be in order for B to be zero at the center of the circle?



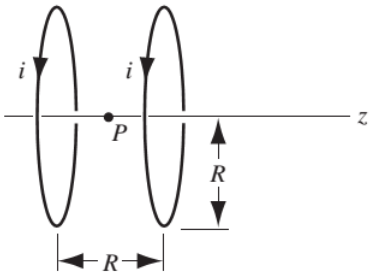
3. *(RHK Exercise 33.15)* The diagram below shows a cross section of a long, thin ribbon of width w that is caryring a uniformly distributed total current I into the page. Calculate the magnitude and the direction fo the magnetic field $\vec{B}$ at the point P in the plane of the ribbon at a distance d from the edge. *(Hint: Imagine the ribbon to be constructed from many long, thin, parallel wires.)*



4. *(RHK Exercise 33.20)* A long wire is bent into the shape shown below (without cross-contact at P). The radius of the circle is R. *(a)* Determine the magnitude and direction of the magnetic field at the center C of the circular portion due to the current I. *(b)* The circular part of the wire is rotated without distortion about the dashed line one quarter turn counterclockwise as viewed from above (so that the plane of the circular loop is now perpendicular to the plaen of the page). Determine $\vec{B}$ at C in this case.



5. *(RHK Problem 33.1)* The diagram below shows an arrangement known as a *Helmholtz coil.* IT consists of two circular coaxial coils each of N turns and radius R, separated by a distance R. They carry equal currents I in the same direction. *(a)* Find the magnetic field at P, midway between the coils. *(b))* Show that both $\mathrm{d}B/ddz$ and $\mathrm{d}^2B/\mathrm{d}z^2$ vanish at the midpoint.



6. *(RHK Problem 33.2)* A straight section of wire of length L carries a current I. *(a)* Show that the magnetic field associated with this segment at P, a perpendicular distance D from one end of the wire, is given by

$$B = \frac{\mu_0 I}{4\pi D} \frac{L}{(L^2 + D^2)^{1/2}} \tag{18.1}$$

(b) Show that the magnetic field is zero at point Q, along the line of the wire.