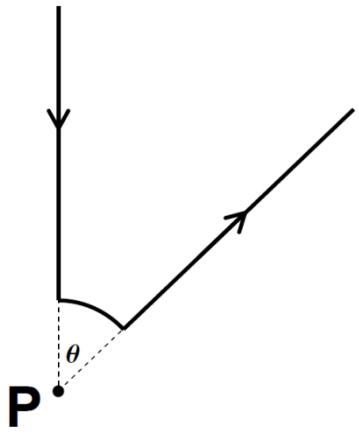
Name: _____ **Problems Solved __/ 7**

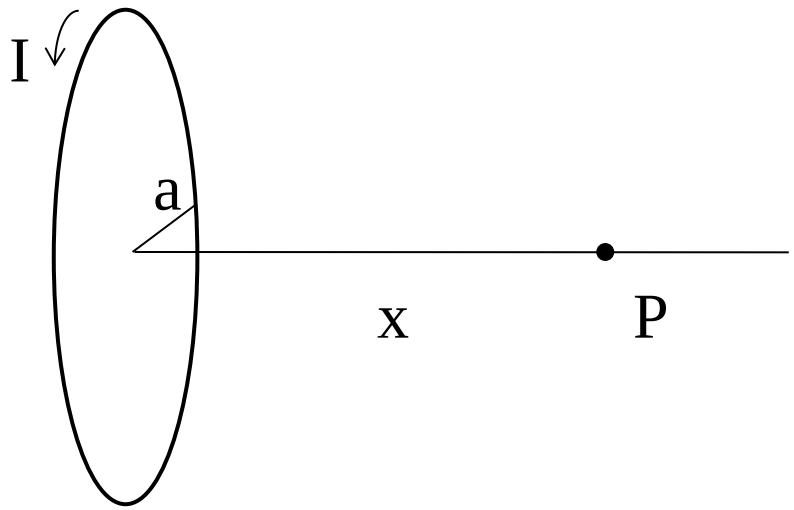
a) Find the magnetic field a distance *R* away from an infinitely long straight wire.
b) Find the magnetic field a perpendicular distance *R* away from the end of a semi-infinite wire,
c) Find the magnetic field a parallel distance *R* away from the end of a semi-infinite wire,

A current path shaped as shown produces a magnetic field. The semi-circular arc subtends an angle of θ and has a radius r. The wire carried current I.

Derive an expression for the magnitude field vector at the center of the arc (point P).



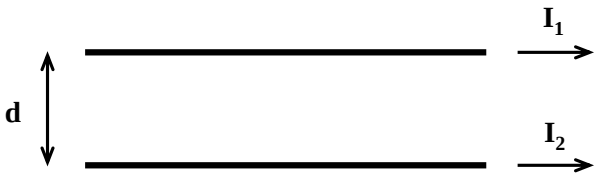
Use the Biot-Savart law to derive a formula for the magnetic field a distance *x* along the axis of a vertical current loop with radius *a* and current *I* (the loop is perpendicular to the page). You may use Example 26.3 in your book as a guide, but be sure that you can eventually solve this problem with no assistance (e.g., on the exam). How does your result simplify for the special case of $x = 0$?



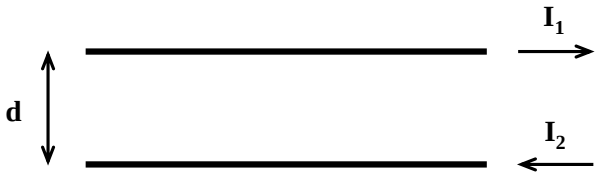
We know that current-carrying wires produce magnetic fields, and we know that magnetic fields exert forces on current-carrying wires. Thus, two parallel current-carrying wires can either attract or repel each other, depending on their current directions.

(a) Consider two wires of length *L* (which is very long), separated by a distance *d*, that carry currents in the same direction. Do the wires attract or repel each other? What is the magnitude and direction of the force $\vec{F}_{21}$ exerted on wire 2 by wire 1? What is the force $\vec{F}_{12}$ exerted on wire 1 by wire 2?

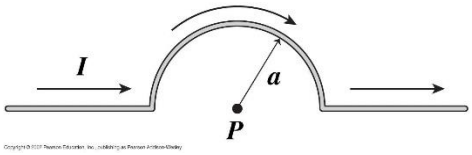
Hint: Consider the B-field produced by wire 1 at the location of wire 2. Use this result to calculate the force on wire 2.



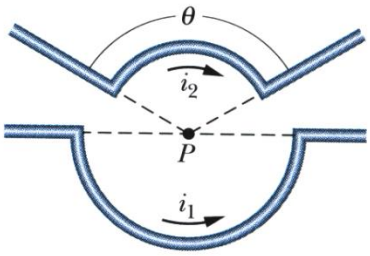
(b) Now repeat the problem for two wires carrying currents in opposite directions.



Part of a long wire is bent into a semicircle of radius *a*, as in the figure below. A current *I* flows in the direction shown. Use the Biot-Savart law to find the magnetic field at the center of the semicircle (point *P*).



The figure shows two current segments. The lower segment carries a current of I_1 and includes a semicircular arc with radius r_1 subtending an angle of 180 degrees a center point P. The upper segment carries current $I_2 = 2I_1$ and includes a circular arc with radius $r_2=0.5r_1$ and subtends an angle of 120 degrees with the same center point P.



a) What is the magnitude and direction of the net magnetic field at point P for the indicated current directions?

b) What are the magnitude and direction of the net magnetic field at point P if I_1 is reversed.

Wolfson, Volume II, 2nd Edition, 26.63

You may use the result $B = \frac{\mu_0 I}{2\pi r}$ from lecture, but be sure you know how to derive it for a long wire using the Biot-Savart law (e.g., on the exam).