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Institution: Beijing-Dublin International College
Module: University Physics 2 (BDIC2008J)
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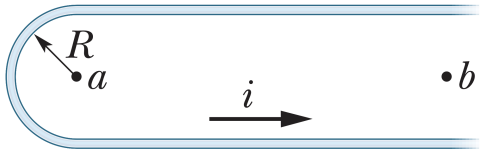
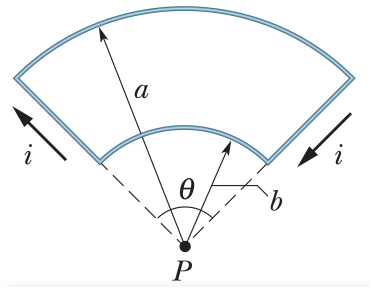
Problem Set 6

Magnetic Fields due to Currents

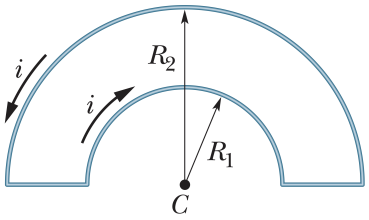
Problem 1. *In the Figure below, a current $i = 10\,\mathrm{A}$ is set up in a long hairpin conductor formed by bending a wire into a semicircle of radius $R = 5.0\,\mathrm{mm}$. Point b is midway between the straight sections and so distant from the semicircle that each straight section can be approximated as being an infinite wire. What are the* ***(a)*** *magnitude and* ***(b)*** *direction (into or out of the page) of $\vec{B}$ at a and the* ***(c)*** *magnitude and* ***(d)*** *direction of $\vec{B}$ at b?*



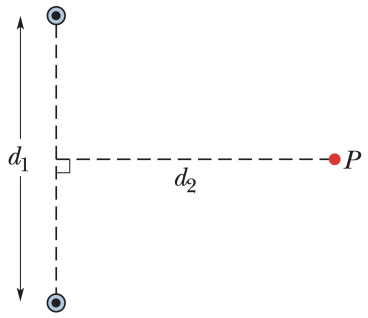
Problem 2. *In the Figure below, two circular arcs have radii* $a = 13.5\,\text{cm}$ *and* $b = 10.7\,\text{cm}$*, subtend angle* $\theta = 74.0°$*, carry current* $i = 0.411\,\text{A}$*, and share the same center of curvature P. What are the* ***(a)*** *magnitude and* ***(b)*** *direction (into or out of the page) of the net magnetic field at P?*



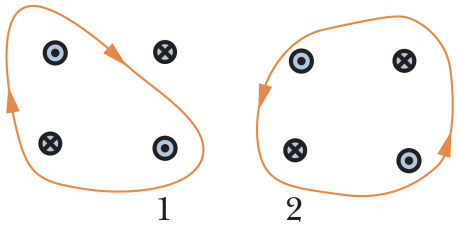
Problem 3. *In the Figure below, two semicircular arcs have radii* $R_2 = 7.80\,\text{cm}$ *and* $R_1 = 3.15\,\text{cm}$*, carry current* $i = 0.281\,\text{A}$*, and have the same center of curvature C. What are the* ***(a)*** *magnitude and* ***(b)*** *direction (into or out of the page) of the net magnetic field at C?*



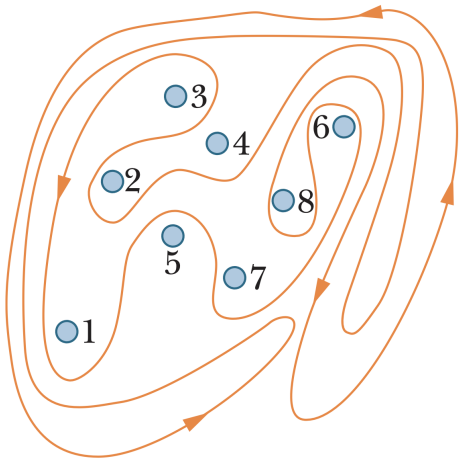
Problem 4. *The Figure shows two very long straight wires (in cross section) that each carry a current of* $4.00\,\mathrm{A}$ *directly out of the page. Distance* $d_1 = 6.00\,\mathrm{m}$ *and distance* $d_2 = 4.00\,\mathrm{m}$. *What is the magnitude of the net magnetic field at point P, which lies on a perpendicular bisector to the wires?*



Problem 5. *Each of the eight conductors in the Figure below carries* 2.0 A *of current into or out of the page. Two paths are indicated for the line integral* $\oint \vec{B} \cdot d\vec{s}$. *What is the value of the integral for* ***(a)*** *path 1 and* ***(b)*** *path 2?*



Problem 6. *Eight wires cut the page perpendicularly at the points shown in the Figure. A wire labelled with the integer* $k\,(k = 1, 2, ..., 8)$ *carries the current* $k \cdot i$*, where* $i = 4.50\,\mathrm{mA}$*. For those wires with odd* k*, the current is out of the page; for those with even* k*, it is into the page. Evaluate* $\oint \vec{B} \cdot d\vec{s}$ *along the closed path indicated and in the direction shown.*



Problem 7. *The current density $\vec{J}$ inside a long, solid, cylindrical wire of radius $a = 3.1\,\mathrm{mm}$ is in the direction of the central axis, and its magnitude varies linearly with radial distance r from the axis according to $J = J_0 r/a$, where $J_0 = 310\,\mathrm{A/m^2}$. Find the magnitude of the magnetic field at* ***(a)*** *$r = 0$,* ***(b)*** *$r = a/2$, and* ***(c)*** *$r = a$.*

Problem 8. *A solenoid that is* 95.0 cm *long has a radius of* 2.00 cm *and a winding of 1200 turns; it carries a current of* 3.60 A. *Calculate the magnitude of the magnetic field inside the solenoid.*

Problem 9. *A long solenoid has* $100\,\text{turns/cm}$ *and carries current* i*. An electron moves within the solenoid in a circle of radius* $2.30\,\text{cm}$ *perpendicular to the solenoid axis. The speed of the electron is* $0.0460c$ *(*c *is the speed of light). Find the current* i *in the solenoid. (Hint mass of electron is* $9.11 \times 10^{-31}\,\text{kg}$*, speed of light is* $3.00 \times 10^{8}\,\text{m/s}$*.)*

Problem 10. *A long solenoid with* $10.0\,\text{turns/cm}$ *and a radius of* $7.00\,\text{cm}$ *carries a current of* $20.0\,\text{mA}$*. A current of* $6.00\,\text{A}$ *exists in a straight conductor located along the central axis of the solenoid.* ***(a)*** *At what radial distance from the axis will the direction of the resulting magnetic field be at* 45.0° *to the axial direction?* ***(b)*** *What is the magnitude of the magnetic field there?*