

# Workbook



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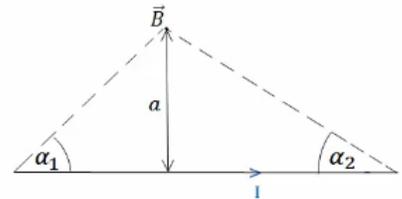
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# Biot Savart Law

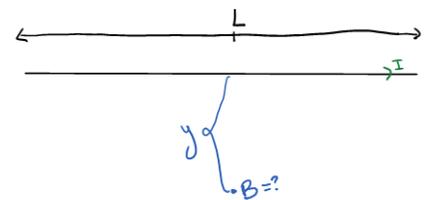
## Biot Savart Law

### Questions

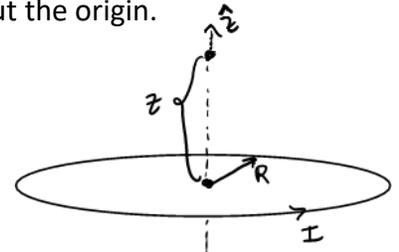
- 1) Show that the magnitude of the magnetic field caused by the current carrying wire, a distance  $a$  from the wire is:  $B = \frac{\mu_0 I}{4\pi a} (\cos \alpha_1 + \cos \alpha_2)$



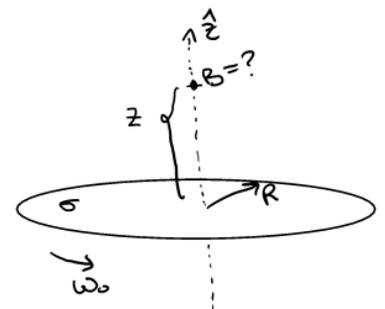
- 2) Calculate the magnetic field at point  $y$  below the middle of a current carrying wire of length  $L$ . The current is flowing in the  $x$  direction.



- 3) Calculate the magnetic field a distance  $z$  away from the center of a current carrying loop of radius  $R$ . The current is travelling in an anticlockwise direction about the origin.



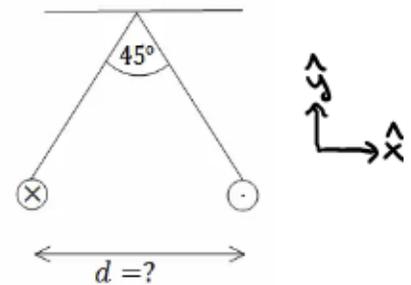
- 4) Calculate the magnetic field a distance  $z$  away from the center of a disk of radius  $R$ , charge density  $\sigma$ , and angular velocity  $\omega_0$  in the anticlockwise direction about the origin.



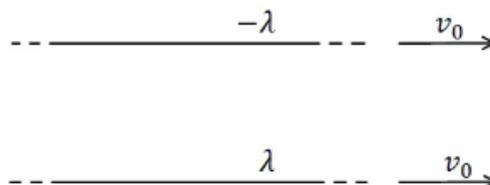
- 5) Three infinite wires are placed parallel to the z-axis.  
 Their positions are:  $\vec{r}_1 = (0,0)$ ,  $\vec{r}_2 = (5,2)$ ,  $\vec{r}_3 = (5,-2)$ .  
 The direction of current in each wire is:  $I_1 = 3A$  out of the page,  $I_2 = 5A$  into the page,  $I_3 = 4A$  into the page.  
 Where along the x-axis does the y component of the magnetic field equal zero?



- 6) Two very long wires are hung from the ceiling via two strings of equal and unknown length. A current of  $100A$  flows through each wire, in opposite directions. There is a  $45^\circ$  angle between the strings, and their mass per unit length is  $= 2 \frac{gr}{m}$ . Find the distance between the wires.

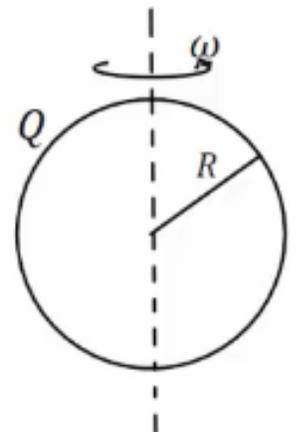


- 7) A current  $I$  flows through a regular n-sided polygon that is enclosed by a circle of radius  $R$ .
- What is the magnetic field at the centre of the polygon?
  - What is the magnetic field at the center of the polygon when  $n \rightarrow \infty$ ?
- 8) Two infinite wires are parallel to one another and have charge distribution  $\lambda$  and  $-\lambda$ . The wires are pulled in the rightwards direction at a constant velocity  $v_0$ . Calculate the magnitude of the velocity such that the magnetic force will cancel out with the electric force.



- 9) Wire  $ACDFG$  includes a circular section of radius  $R$ , and two infinitely long straight regions. The continuation of line  $AC$  cuts through the center of the circle's radius. A current  $I$  flows through the wire.
- What is the magnetic field at the centre of the circular region?
  - A charged particle travels through the centre of the circular region. The particle's trajectory changes due to the magnetic field. The trajectory appears in the diagram. What is the particles charge?
  - In another experiment, a non-uniform magnetic field is present in the region  $R < y < 2R$ . Part of the  $FG$  section of the wire is in the region with the non uniform magnetic field. The magnetic field is  $\vec{B} = (0,0, ay^2)$ , where  $a$  is given. What magnetic force does this field apply to the wire?

- 10) A spherical shell of radius  $R$  has charge  $Q$  evenly distributed on the surface. The shell rotates about its axis of symmetry at a constant angular velocity  $\omega$ . Calculate the magnetic field at the centre of the shell. Assume that the rotation does not affect the charge distribution.



\*For the solutions go see the videos