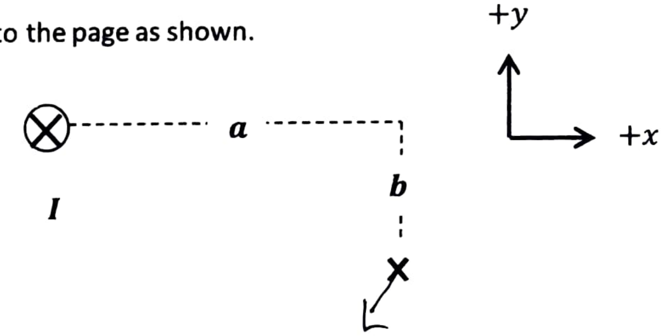
Section	Group	Name	Signature
Grade			
		Jacob Hali	[illegible]

After this activity you should know: • *the direction and magnitude of the magnetic field due to straight thin current segments*

1. A very long (treat as infinite) straight wire carries current I into the page as shown.



   a. Draw a vector showing the magnetic field at the point marked X.

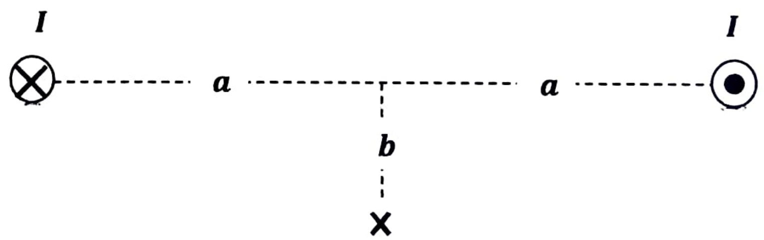
   b. What is the magnitude of the magnetic field at the point X? Write in terms of I, a and b and physical constants.

$$-\frac{\mu_0 I}{2\pi\sqrt{a^2+b^2}}$$

   c. Write the magnetic field at X in component vector form. *You will need to write the sine and cosines you need in terms of a and b.*

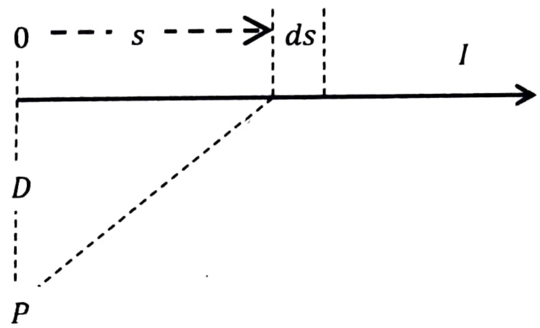
$$\left\langle \frac{\mu_0 I}{2\pi\sqrt{a^2+b^2}}\cdot\frac{a}{\sqrt{a^2+b^2}},\ -\frac{\mu_0 I}{2\pi\sqrt{a^2+b^2}}\cdot\frac{b}{\sqrt{a^2+b^2}} \right\rangle$$

   d. Now consider two wires carrying current I in and out of the page as shown. What is the net magnetic field at the point marked X?



$$2\cdot\frac{I\mu_0}{2\pi\sqrt{a^2+b^2}}$$

2. **Semi-infinite straight current:** Consider the semi-infinite current segment shown which extends to infinity in one direction but is finite in the other direction.



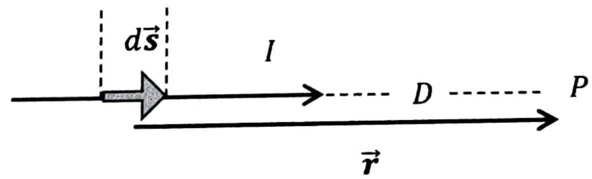
For an infinite wire, the magnetic field at a distance D from the wire is

$$B = \frac{\mu_o I D}{4\pi}\int_{-\infty}^{\infty}\frac{ds}{(s^2 + D^2)^{3/2}} = \frac{\mu_o I}{2\pi D}$$

What is the magnetic field at the point P a distance D from the end of the semi-infinite wire? *Hint: You should be able to figure out the answer without explicitly doing the integral.*

$\frac{\mu_0 I}{4\pi D}$

3. Current head-on to point P: Consider the case where the current is heading straight toward the point where we want the magnetic field. What is the magnetic field at the point P shown?



Hint: consider a small piece $d\vec{s}$ and think about what the Biot-Savart law tells you.

$$d\vec{B} = \frac{\mu_o I\, d\vec{s} \times \hat{r}}{4\pi r^2}$$

Thin about the angle between $d\vec{s}$ and $\hat{r}$.

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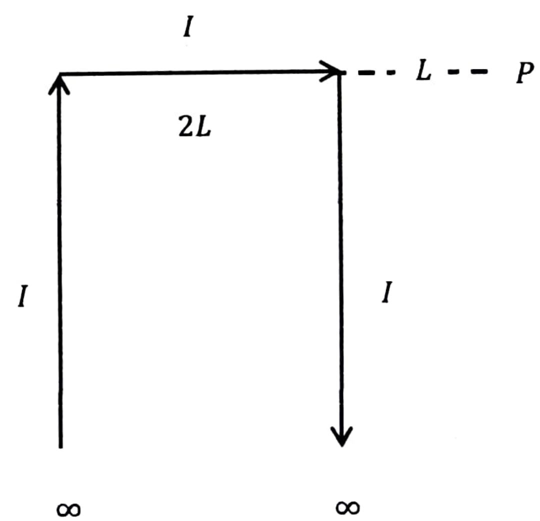
4. A current I undergoes a 180^o turn as shown. What is the magnitude and direction of the magnetic field at the point shown?



$\frac{\mu_0 I}{4\pi D}$