A straight wire of length 0.74 m carries a conventional current of 0.7 amperes. What is the magnitude of the magnetic field made by the current at a location 3.2 cm from the wire? Use both the exact formula and the approximate formula to calculate the field.

(a) result using exact formula

$B =$ ______ T

(b) result using approximate formula

$B =$ ______ T

Part One

$$B = \frac{\mu_0}{4\pi} \frac{LI}{r\sqrt{r^2 + (\frac{L}{2})^2}}$$

$$= 4.359e-6\,T$$

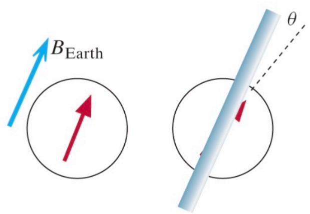
Part Two

$$B = \frac{\mu_0}{4\pi} \frac{2I}{r}$$

$$= 4.375e-6\,T$$

Deflecting a compass needle

When you bring a current-carrying wire down onto the top of a compass, aligned with the original direction of the needle and 7 mm above the needle, the needle deflects by $\theta = 9$ degrees (see the figure).



(a) Which of the following statements are correct? Select all that apply.

- [ ] The magnetic field under the wire, due to the current, points North.
- [x] Conventional current in the wire is flowing downward (South).
- [x] The magnetic field under the wire, due to the current, points to the East.
- [x] Electron current in the wire is flowing upward (North).
- [ ] Conventional current in the wire flows upward (North).
- [ ] The magnetic field under the wire, due to the current, points to the West.

(b) Calculate the amount of conventional current flowing in the wire. The measurement was made at a location where the horizontal component of the Earth's magnetic field is $B_{\text{Earth}} \approx 2 \times 10^{-5}$ tesla.

______ A

$$\tan(\theta) = \frac{|\vec{B}_{wire}|}{|\vec{B}_{earth}|}$$

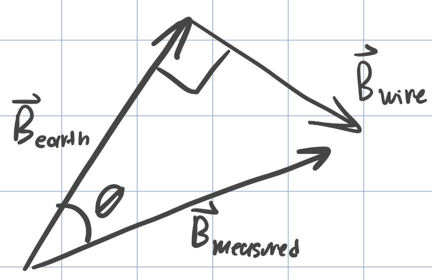
$$|\vec{B}_{wire}| = \tan(\theta)|\vec{B}_{earth}|$$

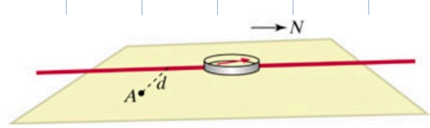
$$\frac{\mu_0}{4\pi}\frac{2I}{r} = \tan(\theta)|\vec{B}_{earth}|$$

$$I = \frac{1}{2} r\tan(\theta)|\vec{B}_{earth}|\frac{1}{\frac{\mu_0}{4\pi}}$$

$$= \frac{1}{2\frac{\mu_0}{4\pi}} r\tan(\theta)|\vec{B}_{earth}|$$

$$= 0.11087A$$





A long current-carrying wire, oriented North-South, lies on a table (it is connected to batteries which are not shown). A compass lies ***on top of the wire***, with the compass needle about 3 mm above the wire. With the current running, the compass deflects 13 degrees to the West. At this location, the horizontal component of the Earth's magnetic field is about 2e-5 tesla.

What is the magnitude of the magnetic field at location *A*, on the table top, a distance 2.8 cm to the East of the wire, due only to the current in the wire?

$|\vec{B}|$ = [ ] tesla

What is the direction of the magnetic field at location *A*, due only to the current in the wire? ---Select---

Equation from the problem above

$$I = \frac{1}{2\frac{\mu_0}{4\pi}} r_{compass}\tan(\theta)B_{earth}$$

$$B_{obs} = \cancel{\frac{\mu_0}{4\pi}}\frac{\cancel{2}\left(\frac{1}{\cancel{2}\cancel{\frac{\mu_0}{4\pi}}} r_{compass}\tan(\theta)B_{earth}\right)}{r_{obs}}$$

$$= \frac{r_{compass}\tan(\theta)B_{earth}}{r_{obs}}$$

$$= 4.947e\text{-}7\ T$$