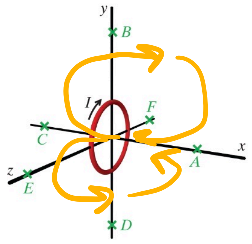


Conventional current flows in a ring in the direction indicated in the diagram (if you stand at location *A*, on the +x axis, and look toward the ring, current flows clockwise). At each of the locations labeled by a letter, use the right hand rule to find the direction of the magnetic field at that location, due to the current in the ring.

Location *A* -x

Location *B* +x

Location *C* -x

Location *D* +x

Location *E* +x

Location *F* +x

(a) A loop of wire carries a conventional current of 0.7 amperes. The radius of the loop is 0.08 m. Calculate the magnitude of the magnetic field at a distance of 0.31 m along the axis of the loop, from the center of the loop.

B = T

(b) What would the magnitude of the magnetic field be at the same location if there were 100 loops of wire in a coil, instead of one loop?

B = T

Part One

$$B_{Loop} = \frac{\mu_0}{4\pi}\frac{2\pi R^2 I}{(z^2+R^2)^{3/2}}$$

$$= 8.5777e-8 \text{ T}$$

Part Two

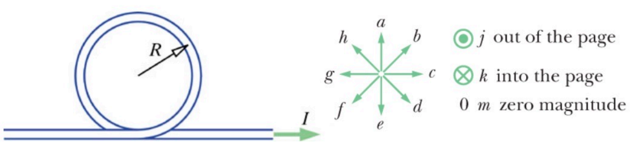
$$B_{100\ loop} = B_{loop} \cdot 100$$

$$= 8.5777e-6 \text{ T}$$

Wire with a loop in it

A very long wire carrying a conventional current of 3.1 amperes is straight except for a circular loop of radius 7.2 cm (see the figure). Calculate the approximate magnitude and the direction of the magnetic field at the center of the loop.

$|\vec{B}|$ = T --Direction--



$$B_{net\,z} = |B_{wire}| + B_{loop}$$

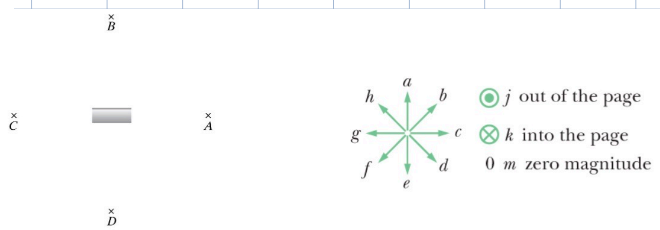
$$= \frac{\mu_0}{4\pi}\frac{2I}{R} + \frac{\mu_0}{4\pi}\frac{2\pi R^2 I}{(\cancel{z^2}+R^2)^{3/2}}$$

$$= \frac{\mu_0}{4\pi}\left(\frac{2I}{R} + \frac{2\pi \cancel{R^2} I}{R^{\cancel{3}}}\right)$$

$$= \frac{\mu_0}{4\pi}\left(\frac{2I}{R} + \frac{2\pi I}{R}\right)$$

$$= \frac{\mu_0}{4\pi}\frac{2I}{R}(1+\pi)$$

$$= 3.566e\text{-}5\ T$$

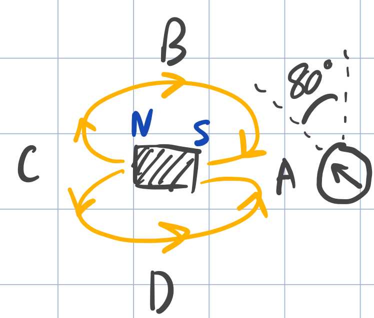


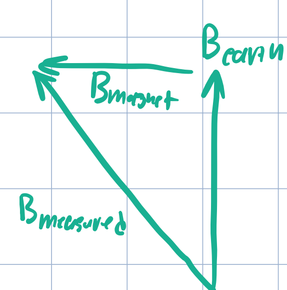
In the region shown in the diagram, the magnitude of the horizontal component of the Earth's magnetic field is about 2e-5 T. Originally a compass placed at location *A* points North. Then a bar magnet is placed at the location shown in the diagram, with its center 18 cm from location *A*. With the magnet present, the compass needle points 80 degrees West of North. (Take North to be toward the top of the page.)

Which pole of the magnet is nearer to location *A*? ---Select---
Which arrow best represents the direction of the magnetic field at location *B*, due to the bar magnet? ---Select---
Which arrow best represents the direction of the magnetic field at location *C*, due to the bar magnet? ---Select---
Which arrow best represents the direction of the magnetic field at location *D*, due to the bar magnet? ---Select---
What is the magnetic dipole moment of the bar magnet?

μ = ____ A*m^2

1.) South
2.) C
3.) G
4.) C



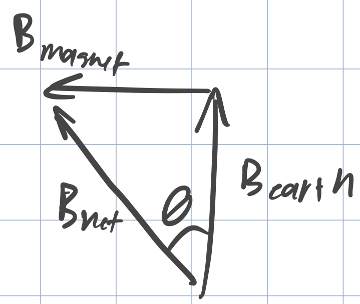


Part Five

$$B = \frac{\mu_0}{4\pi}\frac{2\mu}{r^3}$$

$$\mu = \frac{1}{\frac{\mu_0}{4\pi}} \cdot \frac{r^3 B_{magnet}}{2}$$

Find B_{magnet}



$$\tan(\theta) = \frac{B_{magnet}}{B_{earth}}$$

$$B_{magnet} = B_{earth} \tan(\theta)$$

Sub and solve

$$\mu = \frac{1}{\frac{\mu_0}{4\pi}} \frac{r^3 B_{earth} \tan(\theta)}{2}$$

$$= 3.307 \ Am^2$$

A particular Alnico (aluminum, cobalt, nickel, and iron) bar magnet (magnet A) has a mass of 10 g. It produces a magnetic field of magnitude 6e-05 T at a location 0.16 m from the center of the magnet, on the axis of the magnet.

(a) Approximately what is the magnitude of the magnetic field of magnet A a distance of 0.48 m from the center of the magnet, along the same axis?

$|\vec{B}_A|$ = ______ T

(b) If you removed the original magnet, and replaced it with a magnet made of the same material, but with a mass of 50 g (magnet B), approximately what would be the magnetic field at a location 0.16 m from the center of the magnet, on the axis of the magnet?

$|\vec{B}_B|$ = ______ T

Part One

$$B = k \frac{2\mu}{r^3}$$

$$\frac{Br^3}{2k} = \mu$$

$$\frac{B_{old} r_{old}^3}{2k} = \frac{B_{new} r_{new}^3}{2k}$$

$$B_{old} r_{old}^3 = B_{new} r_{new}^3$$

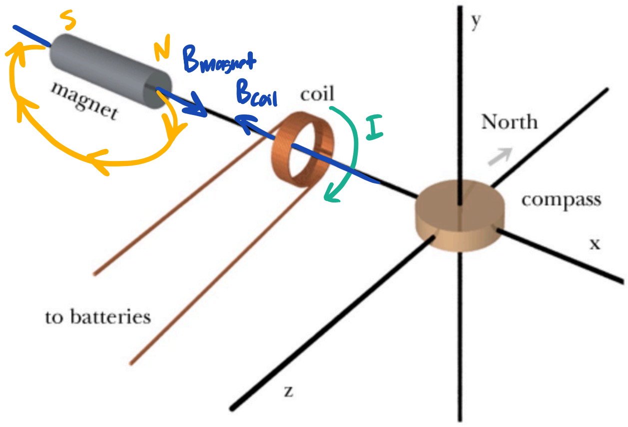
$$B_{new} = \frac{B_{old}\, r_{old}^3}{r_{new}^3}$$

$$= 2.222e6\ T$$

Part Two

$$\frac{6e\text{-}5}{10} = \frac{m}{50}$$

$$m = 3e\text{-}4\ T$$



A bar magnet with magnetic dipole moment 0.51 A m^2 lies on the negative x-axis, as shown in the diagram. A compass is located at the origin. Magnetic North is in the negative z direction. Between the bar magnet and the compass is a coil of wire of radius 1.5 cm, connected to batteries not shown in the picture. The distance from the center of the coil to the center of the compass is 9.6 cm. The distance from the center of the bar magnet to the center of the compass is 21 cm. A steady current of 1.23 amperes runs through the coil. Conventional current runs clockwise in the coil when viewed from the location of the compass.

Despite the presence of the coil and the bar magnet, the compass points North.

Which end of the bar magnet is closer to the compass? ---Select---

Check all of the following statements that are correct:

- ☐ Because not all parts of the magnet are the same distance from the compass, treating the magnet as a dipole located at the center of the magnet is an approximation.
- ☐ At the location of the compass, the net magnetic field is equal to the magnetic field of the Earth.
- ☐ It isn't necessary to take the magnetic field of the magnet into account, since the coil is in between the magnet and the compass.
- ☐ The magnetic dipole moment of the coil is equal to the magnetic dipole moment of the compass.
- ☐ At the location of the compass, the magnetic field due to the magnet is equal in magnitude to the magnetic field due to the coil.

How many turns of wire are in the coil?

number of turns =

Part One

North

Part Two

1, 2, and 5

Part Three

$$B_{magnet} = n B_{coil}$$

$$\cancel{\frac{N}{4\pi}} \frac{\cancel{2}N}{r_{magnet}^3} = n \left(\cancel{\frac{N}{4\pi}} \frac{\cancel{2}\pi R^2 I}{(r_{coil}^2 + R^2)^{3/2}} \right.$$

$$\frac{N_{magnet}}{r_{magnet}^3} = n \frac{\pi R^2 I}{(r_{coil}^2 + R^2)^{3/2}}$$

$$n = \frac{(r_{coil}^2 + R^2)^{3/2} N_{magnet}}{\pi R^2 I r_{magnet}^3}$$

$$= 58.103 \text{ coils}$$