Answer on Question #74425 - Physics – Electromagnetism

Question:

Two long, straight, parallel wires A and B, separated by a distance of 30 cm, carry currents IA = 10A and IB = 30A. The currents in both the wires flow in the same direction. Calculate the net magnetic field at the midpoint of the line joining the two wires and perpendicular to them

Solution:

1. At first we can find the magnetic field of one wire. Ampère's circuital law

$$\mu_0 I = \oint(\vec{B}, \overrightarrow{dl}) = 2\pi RB,$$

if we integrate the magnetic field along the circle with radius *R*. Therefore the magnitude of magnetic field for one wire is

$$B = \frac{\mu_0 I}{2\pi R}$$

where μ_0 ≈1.2566×10^{-6} (N/A^2) -- magnetic constant in vacuum. The distance from the axis of the wire to the midpoint, for both wires is

$$R = \frac{d}{2}$$

where d=30(cm)=0.3(m) is the distance between wires A and B.

2. The vector of the net magnetic field $\vec{B}_{net}$ will be the sum of the vectors $\vec{B}_A$ and $\vec{B}_B$ of parallel wires A and B. We can find directions of the vectors $\vec{B}_A$ and $\vec{B}_B$ with the help of "Right-hand rule". Therefore at the midpoint of the line joining the two wires, the vectors $\vec{B}_A$ and $\vec{B}_B$ will have the opposite direction, and the magnitude of the net magnetic field will be

$$B_{net} = B_B - B_A = \frac{\mu_0 I_B}{2\pi R} - \frac{\mu_0 I_A}{2\pi R} = \frac{\mu_0 (I_B - I_A)}{\pi d}$$

$$B_{net} \approx \frac{1.2566 \times 10^{-6} \times (30 - 10)}{3.14 \times 0.3} \approx 2.67 \times 10^{-5} (T)$$

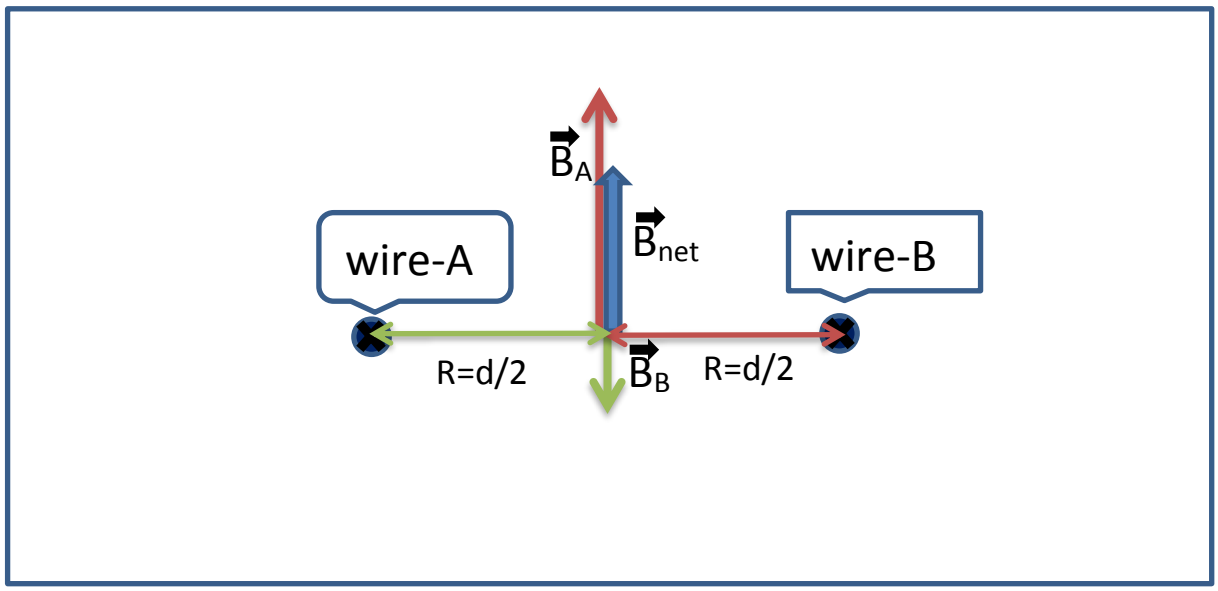

Fig. The magnetic field of one wire with the current I_A (green) and I_B (red); the net magnetic field (blue) at the midpoint of the line joining the two wires.

Answer:

The net magnetic field at the midpoint of the line joining the two wires: $B_{net} \approx 2.67 \times 10^{-5}(T)$

Comments:

1. we use standard SI units:
T—Tesla, m—metre, N—Newton, A -- Ampere
https://en.wikipedia.org/wiki/International_System_of_Units

2. Ampère's circuital law – for example:
https://en.wikipedia.org/wiki/Amp%C3%A8re%27s_circuital_law
(the table -- "Forms of the original circuital law written in SI units")

3. "Right-hand rule"– for example:
https://en.wikipedia.org/wiki/Right-hand_rule

4. the magnetic field of the wire is well-known classical problem. For example, the next:

http://farside.ph.utexas.edu/teaching/302l/lectures/node75.html