Answer on Question #79168- Physics- Electromagnetism

Question: *Long problem #1: Three wires carrying a 1.0-A current in the same direction. The wires are at the corners of an equilateral triangle of side s=1.0m. What is the magnetic field (magnitude and direction) at the center of the triangle?*

Answer:

In order to solve the problem, let us recall that: 1) magnetic field is a vector field; 2) magnetic field obeys the superposition principle. This means that the net magnetic field in the center of an equilateral triangle is the vector sum of the fields created by each wire independently.

According to [1] (see beginning of the section "Magnetic field due to moving charges and electric currents"), a long straight wire creates a magnetic field which lines form concentric circles in a plane which is perpendicular to the direction of the wire. Direction of the field can be obtained via the so-called right hand grip rule (see Fig.1a) and its magnitude can be calculated by means of the following expression:

$$B = \frac{\mu_0 I}{2\pi r}, \qquad (1)$$

where r is the radius of the corresponding circle (it is equal to the shortest distance between the wire and point of observation of the field).

Now let us consider the situation shown in Fig.1b: 3 wires are parallel and the current goes in the same direction for each of them (here we assume that the current is oriented in the direction opposite to the viewer). The lines connecting each wire with the centre of an equilateral triangle intersect at the angles of 120 Degrees. Hence, the vectors of magnetic fields created by each wire in the centre also intersect at the angles of 120 Degrees with each other (see Fig.1c) (because each of them is perpendicular to the corresponding r-line). The magnitude of the net magnetic field can be obtained just by finding its projections on x- and y-axes (here we stress that due to equal r and I for each wire the magnitudes of the constituting B-fields are equal):

$$Ox: \quad -B + 2B\cos 60 = -B + B = 0,$$

$$Oy: \quad B\sin 60 - B\sin 60 = 0. \qquad (2)$$

Consequently, the magnetic field just vanishes.

[1] (Electronic resource) https://en.wikipedia.org/wiki/Magnetic_field

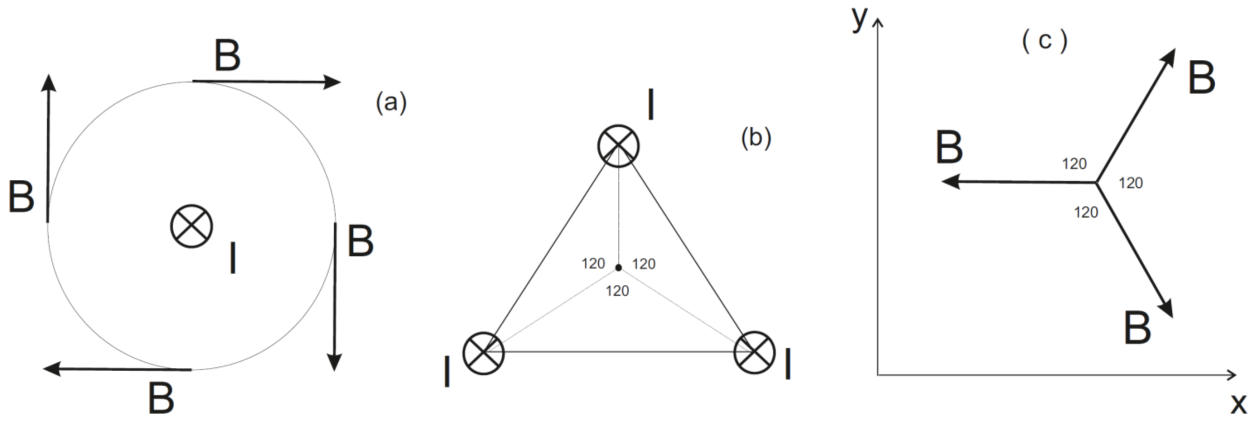

Figure 1.