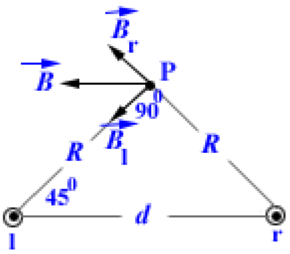
465.

<u>Problem 35.22 (RHK)</u>

Two long straight parallel wires 12.2 cm *apart each carry a current of 115* A. *In the figure cross-section of the circuit has been shown, with the wires running perpendicular to the page and point P lying on the perpendicular bisector of d. We have to find the magnitude and direction of the magnetic field at P when the current in the left-hand wire is out of the page and when the current in the right-hand wire is* (a) *out of the page and* (b) *into the page.*

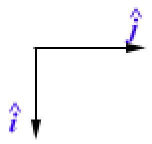


<u>Solution:</u>

The magnitude of the magnetic field at P due to each of the two current carrying wires at will be $\mu_0 i/2\pi R$, but their directions will be different and also depend on whether the current is going into the page or coming out of the page.

(a)

We will consider the two cases of the problem separately. We will use a coordinate system as shown in the figure.



When the current is coming out of the page in the left and the right wires, the magnetic fields at P due to the left and the right wires will be as shown in the figure.

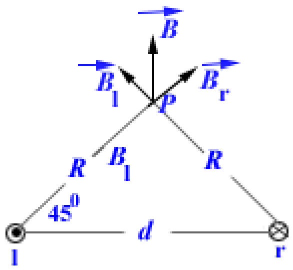
$$\vec{B}(\mathrm{P}) = \vec{B}_{\mathrm{l}} + \vec{B}_{\mathrm{r}} = \frac{\mu_0 i}{2\pi R}\left(-\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}\right) + \frac{\mu_0 i}{2\pi R}\left(+\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}\right)$$

$$= -\frac{\sqrt{2}\mu_0 i}{2\pi R}\,\hat{j} = -\frac{10^{-7}\times 2\times\sqrt{2}\times 115}{12.2\times 10^{-2}}\,\hat{j}\ \mathrm{T}$$

$$= -2.66\times 10^{-4}\,\hat{j}\ \mathrm{T}.$$

(b)

The current in the left wire is out of the page and the current in the right wire is going into the page. In this case the magnetic fields at P due to the left and the right wires will be as shown in the figure below.



The magnetic field at P will be

$$\vec{B}(\mathrm{P}) = \vec{B}_{\mathrm{l}} + \vec{B}_{\mathrm{r}} = \frac{\mu_0 i}{2\pi R}\left(-\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}\right) + \frac{\mu_0 i}{2\pi R}\left(-\frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}\right)$$

$$= -\frac{\sqrt{2}\mu_0 i}{2\pi R}\hat{i} = -\frac{10^{-7}\times 2\times\sqrt{2}\times 115}{12.2\times 10^{-2}}\hat{i}\ \mathrm{T}$$

$$= -2.66\times 10^{-4}\hat{i}\ \mathrm{T}.$$