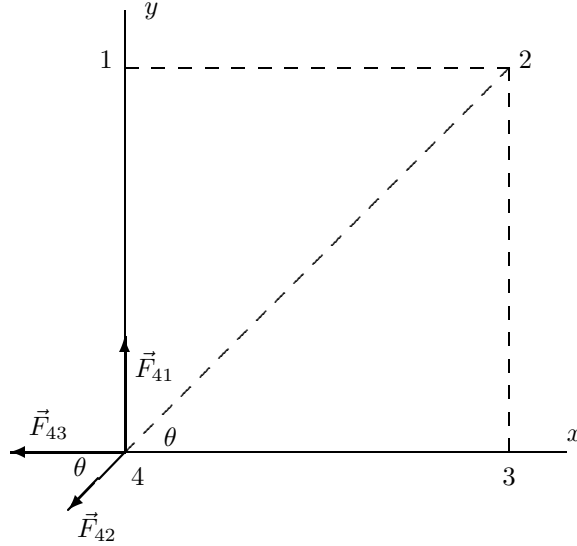


27. We use Eq. 30-15 and the superposition of forces: $\vec{F}_4 = \vec{F}_{14} + \vec{F}_{24} + \vec{F}_{34}$. With $\theta = 45^\circ$, the situation is as shown below:



The components of \vec{F}_4 are given by

$$\begin{aligned} F_{4x} &= -F_{43} - F_{42} \cos \theta \\ &= -\frac{\mu_0 i^2}{2\pi a} - \frac{\mu_0 i^2 \cos 45^\circ}{2\sqrt{2}\pi a} \\ &= -\frac{3\mu_0 i^2}{4\pi a} \end{aligned}$$

and

$$\begin{aligned} F_{4y} &= F_{41} - F_{42} \sin \theta \\ &= \frac{\mu_0 i^2}{2\pi a} - \frac{\mu_0 i^2 \sin 45^\circ}{2\sqrt{2}\pi a} \\ &= \frac{\mu_0 i^2}{4\pi a} . \end{aligned}$$

Thus,

$$F_4 = (F_{4x}^2 + F_{4y}^2)^{1/2} = \left[\left(-\frac{3\mu_0 i^2}{4\pi a} \right)^2 + \left(\frac{\mu_0 i^2}{4\pi a} \right)^2 \right]^{1/2} = \frac{\sqrt{10}\mu_0 i^2}{4\pi a} ,$$

and \vec{F}_4 makes an angle ϕ with the positive x axis, where

$$\phi = \tan^{-1} \left(\frac{F_{4y}}{F_{4x}} \right) = \tan^{-1} \left(-\frac{1}{3} \right) = 162^\circ .$$