STAEDTLER® No. 937 811E Engineer's Computation Pad

••27 Typical backyard ants often create a network of chemical trails for guidance. Extending outward from the nest, a trail branches (*bifurcates*) repeatedly, with 60° between the branches. If a roaming ant chances upon a trail, it can tell the way to the nest at any branch point: If it is moving away from the nest, it has two choices of path requiring a small turn in its travel direction, either 30° leftward or 30° rightward. If it is moving toward the nest, it has only one such choice. Figure 3-31 shows a typical ant trail, with lettered straight sections of 2.0 cm length and symmetric bifurcation of 60°. What are the (a) magnitude and (b) angle (relative to the positive direction of the superimposed x axis) of an ant's displacement from the nest (find it in the figure) if the ant enters the trail at point A? What are the (c) magnitude and (d) angle if it enters at point B?

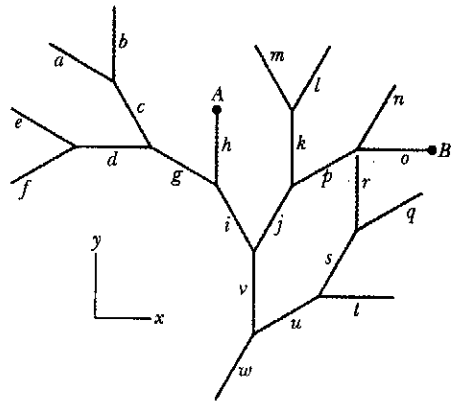


FIG. 3-31
Problem 27.

$\vec{d}_A = \vec{d}_h + \vec{d}_i + \vec{d}_v + \vec{d}_w$

$= [\vec{d}_h = 0\hat{x} + (-d)\hat{y}]$

$+ [d_i = d\cos 300\,\hat{x} + d\sin 300\,\hat{y}]$

$+ [d_v = 0\hat{x} + (-d)\hat{y}]$

$+ [d_w = d\cos 240\,\hat{x} + d\sin 240\,\hat{y}]$

$= d\left[0 + \frac{1}{2} + 0 + \frac{-1}{2}\right]\hat{x}$

$+ d\left[-1 + \frac{-\sqrt{3}}{2} + -1 + \frac{-\sqrt{3}}{2}\right]\hat{y}$

$= 0\hat{x} + -d\left[2 + \sqrt{3}\right]\hat{y}$

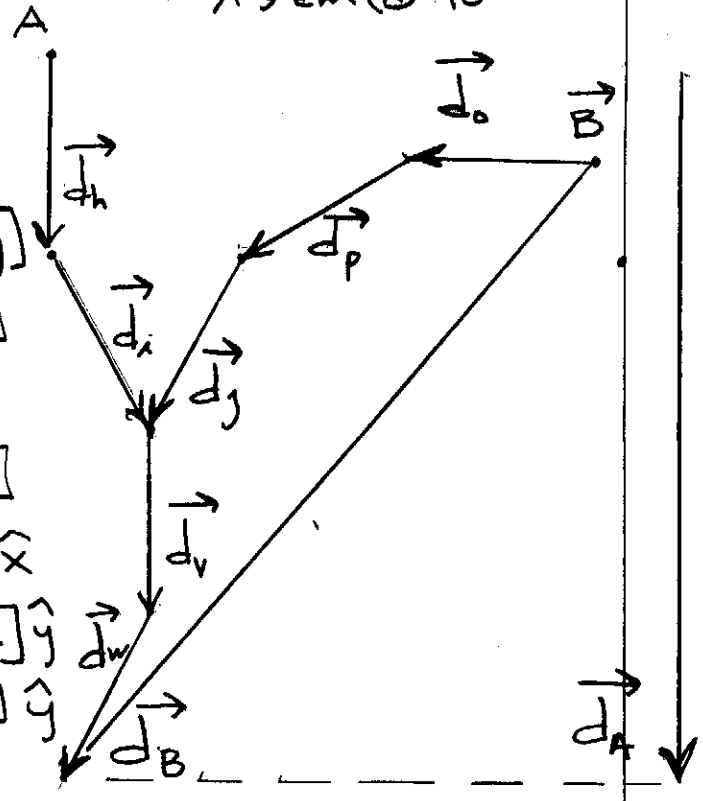
$= 0\hat{x} + -2d\left[1 + 0.866\right]\hat{y}$

$= -3.73\,d\,\hat{y} = -7.5\text{ cm}\,\hat{y}$

$= 7.5\text{ cm} @ 270°$

DISPLACEMENT FROM NEST $= -\vec{d}_A$

$= 7.5\text{ cm} @ 90°$



$\vec{d}_B = \vec{d}_o + \vec{d}_p + \vec{d}_j + \vec{d}_v + \vec{d}_w$

$= [\vec{d}_o = -d\hat{x} + 0\hat{y}]$

$+ [\vec{d}_p = d\cos 210\,\hat{x} + d\sin 210\,\hat{y}]$

$+ [\vec{d}_j = d\cos 240\,\hat{x} + d\sin 240\,\hat{y}]$

$+ [\vec{d}_v = 0\hat{x} + -d\,\hat{y}]$

$+ [\vec{d}_w = d\cos 240\,\hat{x} + \sin 240\,\hat{y}]$

$= d\left[-1 + \frac{-\sqrt{3}}{2} + \frac{-1}{2} + 0 + \frac{-1}{2}\right]\hat{x}$

$+ d\left[0 + \frac{-1}{2} + \frac{-\sqrt{3}}{2} + -1 + \frac{-\sqrt{3}}{2}\right]\hat{y}$

$= -d\left[2 + \sqrt{3}/2\right]\hat{x} + -d\left[3/2 + \sqrt{3}\right]\hat{y}$

$= -2.87\,d\,\hat{x} - 3.23\,d\,\hat{y}$

$= -5.7\,\hat{x} - 6.5\,\hat{y}$

$= \vec{d}_B \quad d_B = \sqrt{d_{Bx}^2 + d_{By}^2} = \sqrt{[2(2.87)]^2 + [2(3.23)]^2} = 8.6\text{cm}$

$\tan^{-1}(|d_{By}|/|d_{Bx}|) = \tan^{-1}(3.23/2.87) = 48° \Rightarrow 228°$

DISPLACEMENT FROM NEST $= -\vec{d}_B = 8.6\text{cm} @ 48°$

48.4