105. (Fourth problem in **Cluster 1**)

Following the hint, we have the time-reversed problem with the ball thrown from the ground, towards the right, at 60° measured counterclockwise from a rightward axis. We see in this time-reversed situation that it is convenient to use the familiar coordinate system with $+x$ as *rightward* and with positive angles measured counterclockwise. Lengths are in meters and time is in seconds.

(a) The x-equation (with $x_0 = 0$ and $x = 25.0$) leads to $25 = (v_0 \cos 60°)(1.50)$, so that $v_0 = 33.3$ m/s. And with $y_0 = 0$, and $y = h > 0$ at $t = 1.50$, we have $y - y_0 = v_{0y}t - \frac{1}{2}gt^2$ where $v_{0y} = v_0 \sin 60°$. This leads to $h = 32.3$ m.

(b) Although a somewhat easier method will be found in the energy chapter (especially Chapter 8), we will find the "final" velocity components with the methods of §4-6. Note that we're still working the time-reversed problem; this "final" $\vec{v}$ is actually the velocity with which it was thrown. We have $v_x = v_{0x} = 33.3 \cos 60° = 16.7$ m/s. And $v_y = v_{0y} - gt = 33.3 \sin 60° - (9.8)(1.50) = 14.2$ m/s. We convert from rectangular to polar in terms of the magnitude-angle notation:

$$\vec{v} = (16.7, 14.2) \longrightarrow (21.9 \angle 40.4°) .$$

We now interpret this result ("undoing" the time reversal) as an initial velocity (from the edge of the building) of magnitude 22 m/s with angle (down from leftward) of 40°.