PRACTICE D

Projectiles Launched Horizontally

1. A baseball rolls off a 0.70 m high desk and strikes the floor 0.25 m away from the base of the desk. How fast was the ball rolling?
2. A cat chases a mouse across a 1.0 m high table. The mouse steps out of the way, and the cat slides off the table and strikes the floor 2.2 m from the edge of the table. When the cat slid off the table, what was its speed?
3. A pelican flying along a horizontal path drops a fish from a height of 5.4 m. The fish travels 8.0 m horizontally before it hits the water below. What is the pelican's speed?
4. If the pelican in item 3 was traveling at the same speed but was only 2.7 m above the water, how far would the fish travel horizontally before hitting the water below?

Use components to analyze objects launched at an angle

Let us examine a case in which a projectile is launched at an angle to the horizontal, as shown in **Figure 17.** The projectile has an initial vertical component of velocity as well as a horizontal component of velocity.

Suppose the initial velocity vector makes an angle θ with the horizontal. Again, to analyze the motion of such a projectile, you must resolve the initial velocity vector into its components. The sine and cosine functions can be used to find the horizontal and vertical components of the initial velocity.

$$v_{x,i} = v_i \cos\theta \quad \text{and} \quad v_{y,i} = v_i \sin\theta$$

We can substitute these values for $v_{x,i}$ and $v_{y,i}$ into the kinematic equations to obtain a set of equations that can be used to analyze the motion of a projectile launched at an angle.

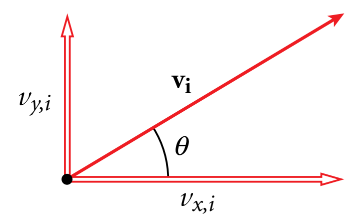

Figure 17
An object is projected with an initial velocity, $\mathbf{v_i}$, at an angle of θ. Resolve the initial velocity into its x and y components. Then, the kinematic equations can be applied to describe the motion of the projectile throughout its flight.

PROJECTILES LAUNCHED AT AN ANGLE

$$v_x = v_{x,i} = v_i \cos\theta = \text{constant}$$
$$\Delta x = (v_i \cos\theta)\Delta t$$
$$v_{y,f} = v_i \sin\theta + a_y \Delta t$$
$$v_{y,f}^2 = v_i^2 (\sin\theta)^2 + 2a_y \Delta y$$
$$\Delta y = (v_i \sin\theta)\Delta t + \tfrac{1}{2}a_y(\Delta t)^2$$

As we have seen, the velocity of a projectile launched at an angle to the ground has both horizontal and vertical components. The vertical motion is similar to that of an object that is thrown straight up with an initial velocity.