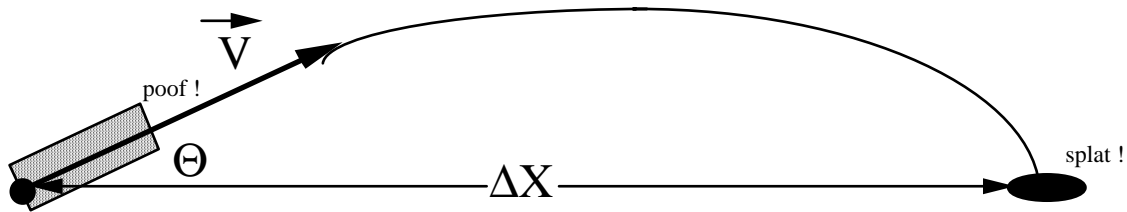


## Using Spreadsheets to Explore Science

Consider the following physics problem:

A cannon fires a circus performer at a velocity  $V$  at an angle  $\Theta$  as shown below:



Neglecting air resistance, at what angle  $\Theta$  should the cannon be aimed so that the distance the performer travels before hitting the ground ( $\Delta X$ ) is a maximum?

We know from projectile physics that, neglecting air resistance, the ill-fated performer will travel in a parabolic arc. Writing the equation for the Y component:

$$Y_2 = Y_1 + V_y \cdot t + 1/2 A_y \cdot t^2$$

Because the initial heights and the final heights are both zero, the initial velocity is  $V \cdot \sin \Theta$ , and the acceleration is due to gravity, we get:

$$0 = 0 + V \cdot \sin \Theta \cdot t - 1/2 \cdot g \cdot t^2$$

Solving for the time when the performer hits the ground:

$$t^* = 2 \cdot V \cdot \sin \Theta / g$$

Using  $t^*$  in the equation for  $\Delta X$ :

$$\Delta X = V_x \cdot t^* = V \cdot \cos \Theta \cdot t^*$$

Things to note when putting this into a spreadsheet:

- Angles used in the **SIN( )** and **COS( )** functions must be in radians. Thus, degrees must first be multiplied by  $(\pi/180)$ . In Excel,  $\pi$  is obtained with the function **PI( )**.
- Numbers whose cells will always stay in the same location, such as the gravitational constant g, must be specified in the form **\$B\$1** instead of **B1**.