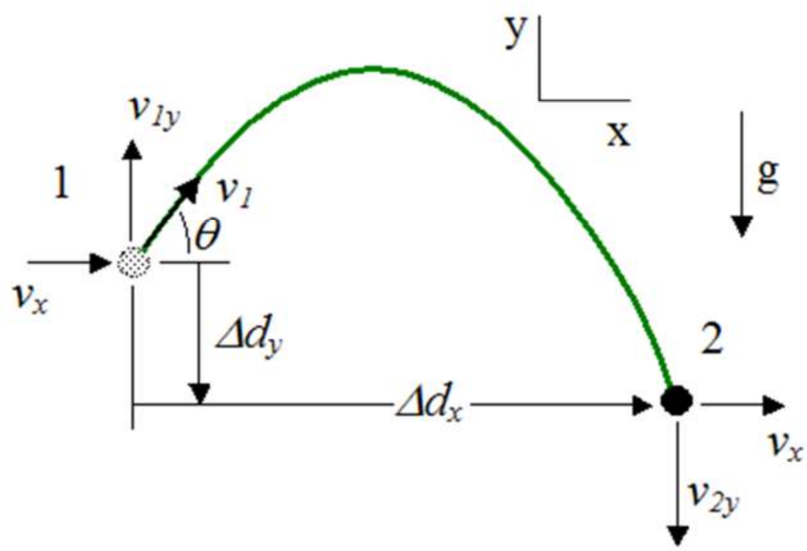
Projectile Motion

Projectile motion describes the motion of objects, which have the force of gravity and air resistance acting on them. In many problems, air resistance is neglected in the analysis. This is done to simplify the calculations.

The figure below shows the motion of a particle, under the influence of gravity only.



Define the following variables:

Δd_x is the change in horizontal position

v_x is the horizontal velocity (constant)

t is time

Δd_y is the change in vertical position

v_{1y} is the initial vertical velocity

g is the acceleration due to gravity, which on earth is 9.8 m/s^2

v_{2y} is the final vertical velocity

v_1 is the initial launch velocity

θ is the initial launch angle, as shown

We are assuming no air resistance. So the particle travels exactly as it would while in a vacuum. Thus, we have the following equations describing the motion of a particle (projectile) in the absence of air resistance:

$$\Delta d_x = (v_x)t$$

$$\Delta d_y = (v_{1y})t - \frac{1}{2}gt^2$$

$$v_{2y} = v_{1y} - gt$$

$$(v_{2y})^2 = (v_{1y})^2 - 2g(\Delta d_y)$$

$$v_x = v_1 \cos\theta \ \text{(constant)}$$

$$v_{1y} = v_1 \sin\theta$$

Note that the horizontal velocity v_x is treated here as constant because it is assumed there is no force acting on the particle in the horizontal direction, since air resistance is neglected. Therefore, only the vertical velocity of the particle changes since there is only a vertical (gravitational) force acting on the particle.

Note that the above equations are a direct result of applying the equations of **rectilinear motion** using constant vertical acceleration in the downward direction (*g*), and zero acceleration in the horizontal direction (since there is no force acting on the particle in the horizontal direction, since air resistance is neglected).