Projectile Motion

Theory

A body given an initial velocity near the surface of the earth accelerates downward at 9.8 m/s^2 if air resistance is negligible. Thus the acceleration is exactly the same in both magnitude and direction as for a body in free fall. This means that the x component of a projectile's velocity is constant, while the y component of velocity is continually decreasing at the rate of 9.8 m/s^2.

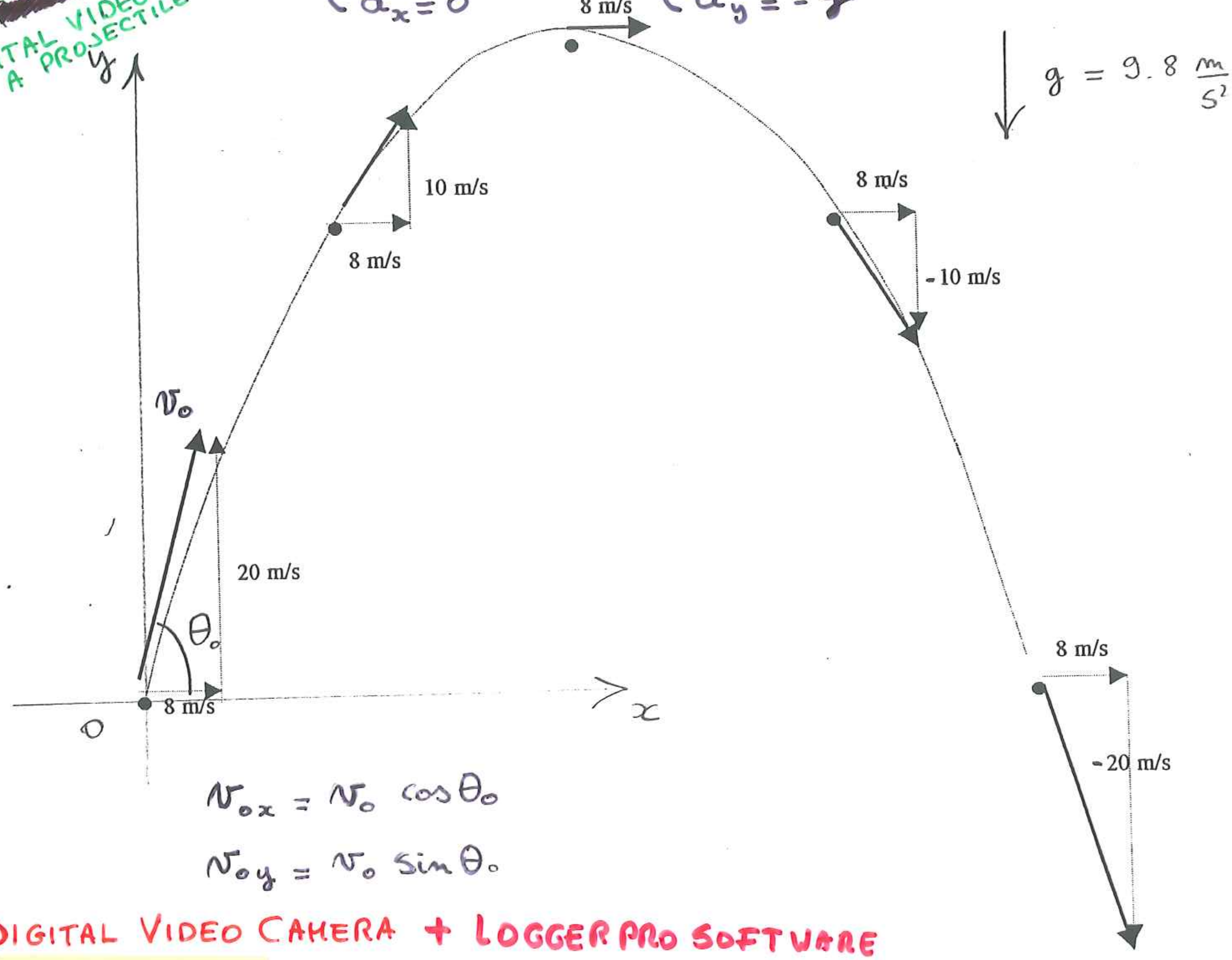
The figure below shows a particularly simple numerical example of projectile motion. The projectile and its velocity are shown at one second intervals. The values of velocity components are given to one significant figure. Note that the y component of velocity changes by – 10 m/s each second.

The following equations give the coordinates and velocity components as a function of time for a projectile that starts at the origin at t = 0, with initial velocity components v_{x0} and v_{y0}.

$$\begin{cases} x = v_{x0}t \\ v_x = v_{x0} \\ a_x = 0 \end{cases} \qquad \begin{cases} y = v_{y0}t - 1/2\, g\, t^2 \\ v_y = v_{y0} - gt \\ a_y = -g \end{cases}$$

PART I

DIGITAL VIDEO OF A PROJECTILE

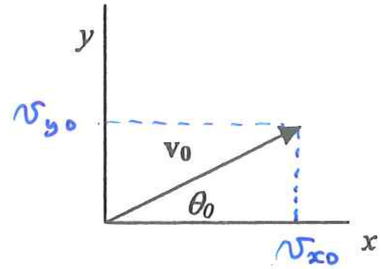


$$v_{ox} = v_o \cos\theta_o$$

$$v_{oy} = v_o \sin\theta_o$$

* DIGITAL VIDEO CAMERA + LOGGER PRO SOFTWARE

The trajectory of a projectile is determined by its initial velocity v_0, a vector of magnitude \`v_0 (initial speed), directed at an angle θ_0 above the x axis.



$$\begin{cases} v_{x0} = v_0 \cos\theta_0 \\ v_{y0} = v_0 \sin\theta_0 \end{cases}$$

PART II - MAXIMIZING HORIZONTAL DISTANCE

LAUNCHER

1) A projectile's horizontal range R, shown in the figure below, can be found by using the kinematic equations to solve for the value of x corresponding to $y = 0$. This special value of x is labeled R:

$$R = \frac{v_0^2 \sin(2\theta_0)}{g}$$

LAUNCHER ⇝ $\boxed{\text{1 CLICK SETTING}}$

R IS MAX FOR $\theta_0 = \ldots$

USE THIS TO FIND v_0

[redacted]