Chapter 04

1a $v_i = v_0$ $\quad y(max) = ?$ $\quad \Delta t = ?$

1b Assumptions and Simplifications

2-D motion (ignore the third dimension)

Treat the projectile as a particle.

Ignore air resistance.

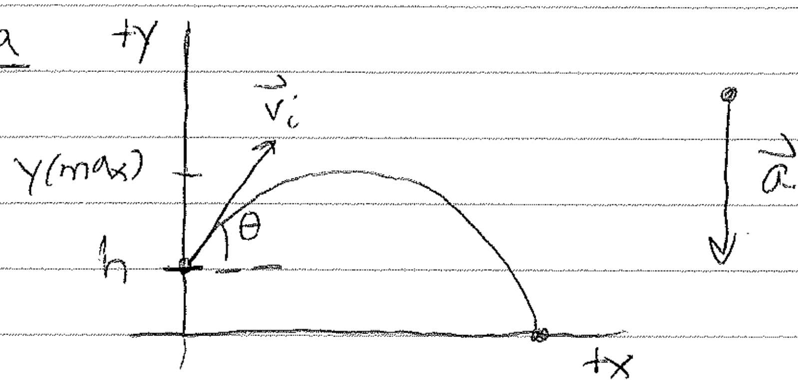
Assume constant acceleration

Concepts and Laws

Projectile Motion

Kinematics in 2-D for constant acceleration

2a



2b $v_{yf}^2 = v_{yi}^2 - 2a_y \Delta y$

$\vec{y}_f = \vec{y}_i + \vec{v}_{iy} \Delta t + \frac{1}{2} \vec{a}_y (\Delta t)^2$

3a Solve $\quad (0\,m/s)^2 = (v_0 \sin\theta)^2 - 2g(y(max) - h)$

$$y(max) = \frac{(v_0 \sin\theta)^2}{2g} + h$$

$$0 = h + v_0 \sin\theta(\Delta t) - \frac{1}{2} g(\Delta t)^2$$

$$\frac{1}{2}(\Delta t)^2 - \frac{v_0 \sin\theta}{g}(\Delta t) - \frac{h}{g} = 0$$

$$\Delta t = \frac{-\left(\frac{-v_0 \sin\theta}{g}\right) \pm \sqrt{\left(\frac{-v_0 \sin\theta}{g}\right)^2 - 4\left(\frac{1}{2}\right)\left(\frac{-h}{g}\right)}}{2\left(\frac{1}{2}\right)}$$

$$\Delta t = \frac{v_0 \sin\theta}{g} \pm \sqrt{\frac{(v_0 \sin\theta)^2}{g^2} + \frac{2h}{g}}$$

$$\Delta t = \frac{v_0 \sin\theta}{g} \pm \sqrt{\frac{(v_0 \sin\theta)^2 + 2hg}{g^2}}$$

$$\Delta t = \frac{v_0 \sin\theta \pm \sqrt{(v_0 \sin\theta)^2 + 2hg}}{g}$$

Since $\Delta t > 0\,s$ use + sign

$$\Delta t = \frac{v_0 \sin\theta + \sqrt{(v_0 \sin\theta)^2 + 2hg}}{g}$$

4a Evaluate Check units!

(a) $y(max) = \frac{(v_0 \sin\theta)^2}{2g} + h \qquad m = \frac{(m/s)^2}{(m/s^2)} + m$ ✓

(b) $\Delta t = \frac{v_0 \sin\theta + \sqrt{(v_0 \sin\theta)^2 + 2hg}}{2g}$

$$s = \frac{(m/s) + \left((m/s)^2 + (m)(m/s^2)\right)^{1/2}}{(m/s^2)} = \frac{(m/s)}{(m/s^2)}$$ ✓