Day 1

11:19 AM

Unit 5: Projectiles

In this unit we will combine kinematics (Unit 3) and vectors (Unit 4).

A projectile is any object launched into the air. It will have vertical and horizontal motion.

Our objects accelerate downward at $-9.8\ m/s^2$ due to gravity. $\vec{a}_y = \vec{g} = -9.8\ m/s^2$

Always remember to use negative values for downward motion.

The motion in the y-direction is independent of the motion in the x-direction. The only thing that works in both directions is time.

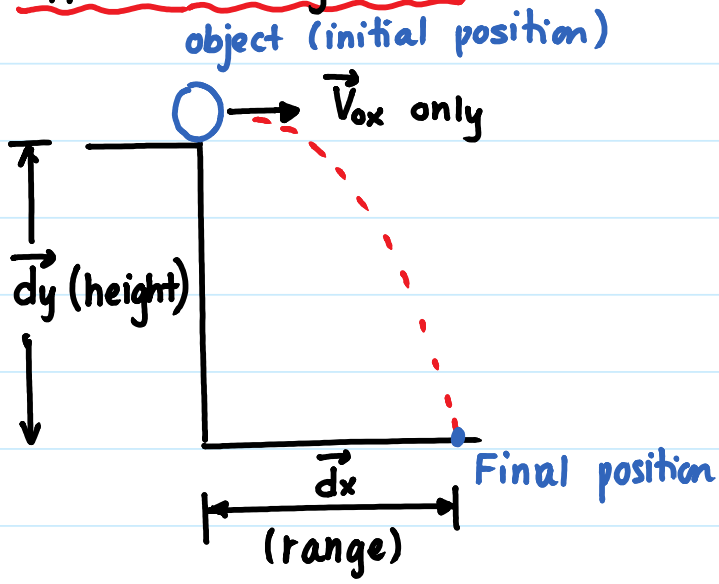
The most commonly used equation will be:

$$\vec{d} = \vec{V}_o t + \frac{1}{2}\vec{a}t^2 \longrightarrow \vec{d}_x = \vec{V}_{ox} t + \frac{1}{2} a_x t^2$$

$d = v_0 t + \frac{1}{2} a t^2 \longrightarrow d_x = v_{0x} t + \frac{1}{2} a_x t^2$

$$\vec{d}_y = \vec{V}_{0y} t + \frac{1}{2} a_y t^2$$

Type 1 Projectiles

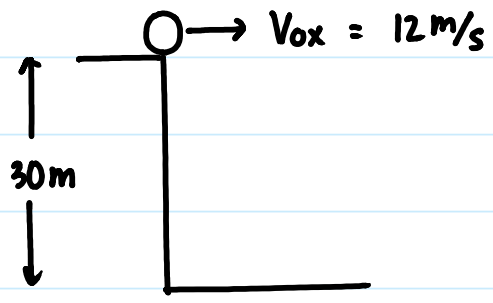


- object starts above ground
- object is always shot horizontally
  - → $\vec{V}_{0x}$ given
  - → $\vec{V}_{0y} = 0$
- $\vec{d}_y$ is always negative
- $\vec{a}_x = 0$ (always)
- $\vec{a}_y = -9.8\ m/s^2$

Example 1: A rock is launched horizontally off a $d_y = 30m$ high cliff at $12\ m/s$. $\vec{V}_{0x}$

a) How long does it take to hit the ground?

↳ time ?



$d_y = -30m$

$V_{0y} = 0$ (always for Type 1)

$\vec{a}_y = -9.8\ m/s^2$

$$\vec{d}_y = \vec{V}_{0y} t + \frac{1}{2} a_y t^2$$

$$-30 = \cancel{(0)t} + \frac{1}{2}(-9.8)t^2$$

$$-30 = -4.9t^2$$

$$\frac{-30}{-4.9} = \frac{-4.9t^2}{-4.9}$$

$$\sqrt{6.122} = \sqrt{t^2}$$

$$2.5 \text{ sec} = t$$

b) How far from the base of the cliff will the rock hit the ground? $\boxed{dx}$

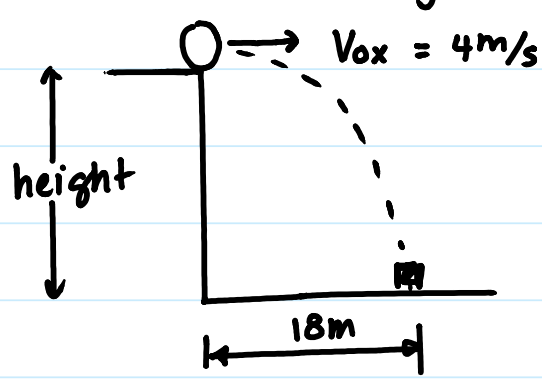
$dx = ?$

$$\vec{d}_x = \vec{V}_{ox}t + \frac{1}{2}\vec{a}_x t^2$$

$$= (12)(2.5) + \cancel{\frac{1}{2}(0)(2.5)^2}$$

$$dx = 30 \text{ m}$$

Example 2: A rock is thrown horizontally at 4 m/s off a building into a bucket which is 18 m from the base of the building. How high is the building?



$\vec{d}_x = 18\text{m}$ $\quad$ $\vec{d}_y = ?$

$\vec{a}_x = 0$ $\quad$ $\vec{a}_y = -9.8 \text{ m/s}^2$

$\vec{V}_{ox} = 4 \text{ m/s}$ $\quad$ $\vec{V}_{oy} = 0$

$$\vec{d}_x = \vec{V}_{ox}t + \cancel{\frac{1}{2}a_x t^2}$$

$$\frac{18}{4} = \frac{4t}{4}$$

$$4.5 \text{ sec} = t$$ } Use this to solve for dy.

4.5 sec = t] use this to solve for dy.

$$\vec{d_y} = \cancel{\vec{V}_{oy}t} + \frac{1}{2}\vec{a}_y t^2$$

$$= \frac{1}{2}(-9.8)(4.5)^2$$

$$= -99.2 \text{ m} \quad \text{or} \quad -99 \text{ m}$$

displacement (rock went down to the ground)

building's height = 99 m

p. 136 # 1ab, 2, 3, 4