

A ball is thrown upward at 10 m/s.

- How high did it go?
- How much time did it take to get to the top?
- How much time does it take to go up and come back down to the start position?

- a) Trick for finding the maximum height: At the top, it comes to a momentary halt: $v = 0$

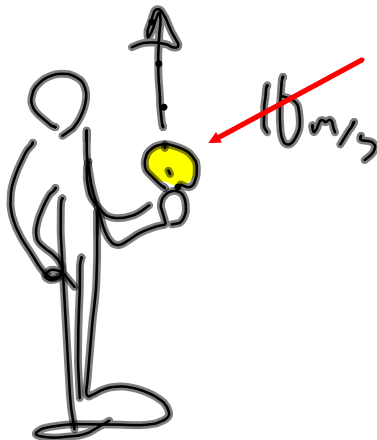
$$v_0 = 10 \text{ m/s}$$

$$v = 0$$

$$a = -10 \text{ m/s/s}$$

$$y_0 = 0$$

$$y = ?$$



I'm picking the origin at the ball's start position

$$v^2 = v_0^2 + 2a(y - y_0)$$

$$0^2 = 10^2 + 2(-10)(y - 0)$$

$$0 = 100 + -20y$$

$$-100 = -20y$$

$$5 \text{ m} = y \quad \text{That number looks familiar!}$$

b)

$$v_o = 10 \text{ m/s}$$

$$v = 0$$

$$a = -10 \text{ m/s/s}$$

$$y_o = 0$$

$$t = ?$$

$$v = v_o + at$$

$$0 = 10 + -10t$$

$$-10 = -10t$$

$$1 \text{ s} = t$$

Could you have predicted that ahead of time?

- c)** To find the time for the complete up and down, set the start position to be the same as the end position: the origin

$$v_o = 10 \text{ m/s}$$

$$a = -10 \text{ m/s/s}$$

$$y_o = 0$$

$$y = 0$$

$$t = ?$$

$$y = y_o + v_o t + \frac{1}{2}at^2$$

$$0 = 0 + 10t + \frac{1}{2}(-10)t^2$$

$$0 = 10t + -5t^2$$

$$-10t = -5t^2$$

$$2 \text{ s} = t$$

In free-fall, the up and the down are symmetrical. Therefore it should take the same time to come down as it did to go up. $1 \text{ s} + 1 \text{ s} = 2 \text{ s}$

Free fall tricks...

1. Always set $a = -10 \text{ m/s/s}$
2. To find the time to the top, set the later velocity to zero: $v = 0$
3. To find the time to go up and come down, set the start position equal to the end position: y and y_0 are the same
4. Time to go up = time to come down
5. It doesn't hurt to remember the free fall patterns:
 - a) velocity changes by -10 m/s every s
 - b) changes in position each second: 5 m , 20 m , 45 m , 80 m , ...