Name:________________________________ December 19, 2013

# Classic Example: Parabolic Motion

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## 1 The Problem: Parabolic Motion

It turns out that throwing a ball into the air looks like a parabola

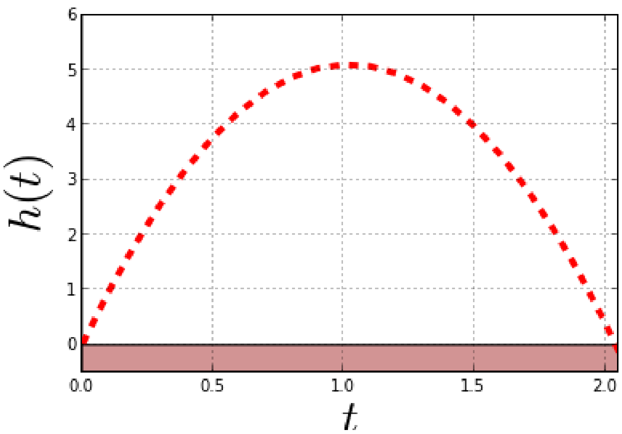
$$h(t) = \frac{1}{2}gt^2 + v\ t + h_0$$

where

- $h(t)$ is the height (in meters) of the ball at time $t$ (in seconds),
- $g$ is the Earth's gravitational acceleration, $9.8m/s^2$,
- $v$ is the initial velocity of the ball before you throw it, and
- $h_0$ is the initial height of the ball when you throw it.

## 2 Throwing a ball into the air

If I plot time versus the height of the ball, it looks something like




If I throw the ball into the air with a velocity of $10m/s$, starting from the ground ($h_0 = 0$):

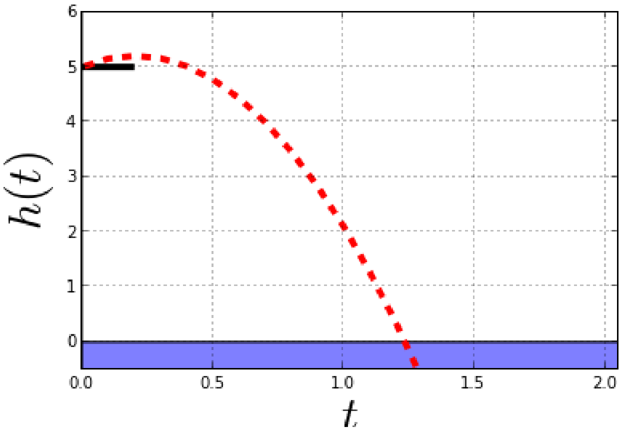
1. Write down the equation of the parabola for the height of the ball

2. How high will the ball fly into the air?
   - **Hint: it's the vertex of the parabola**

3. When will the ball hit the ground?
   - **Hint: it's the zero of the quadratic**

## 3 Diving Board

What if you've got a diver who jumps from a $5m$ board and that shoots them up at $2m/s$?




1. Write down the equation of the parabola for the height of the diver

2. How high will the diver fly into the air?

3. When will the diver hit the water?

4. If the diver is moving away from the board at $3m/s$, how far from the board will they land? Use your time from question three:

$$D = t \cdot (3m/s)$$

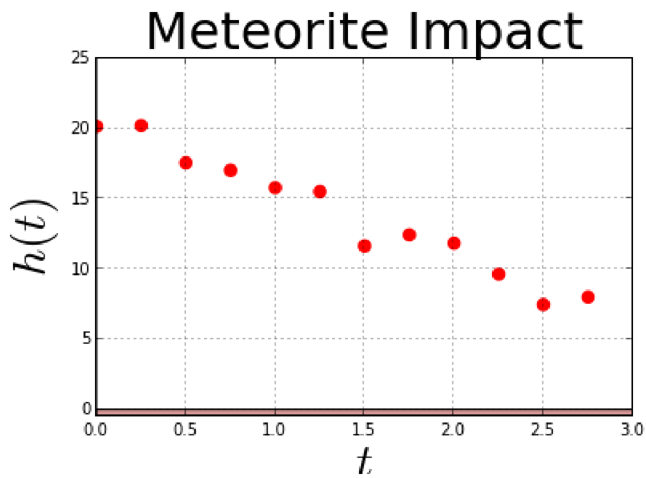
## 4 Space Balls

$g = 9.8 m/s^2$ on Earth, but how about on other planets? The acceleration due to gravity depends on how massive the planet is. For instance:

Table 1: Gravity on other planets

| Planet | g = |
|---|---|
| Mercury | $3.61\ m/s^2$ |
| Venus | $8.83\ m/s^2$ |
| Earth | $9.8\ m/s^2$ |
| Mars | $3.75\ m/s^2$ |
| Pluto | $0.61\ m/s^2$ |

Lets say I have some measurements of something hitting a planet,




With data:

| t | h(t) |
|---|---|
| 0.0 | 20.1 |
| 0.25 | 20.2 |
| 0.5 | 17.6 |
| 0.75 | 17.0 |
| 1.0 | 15.8 |
| 1.25 | 15.5 |
| 1.5 | 11.6 |
| 1.75 | 12.4 |
| 2.0 | 11.8 |
| 2.25 | 9.6 |
| 2.5 | 7.4 |
| 2.75 | 8.0 |

1. What planet did this thing fall on?