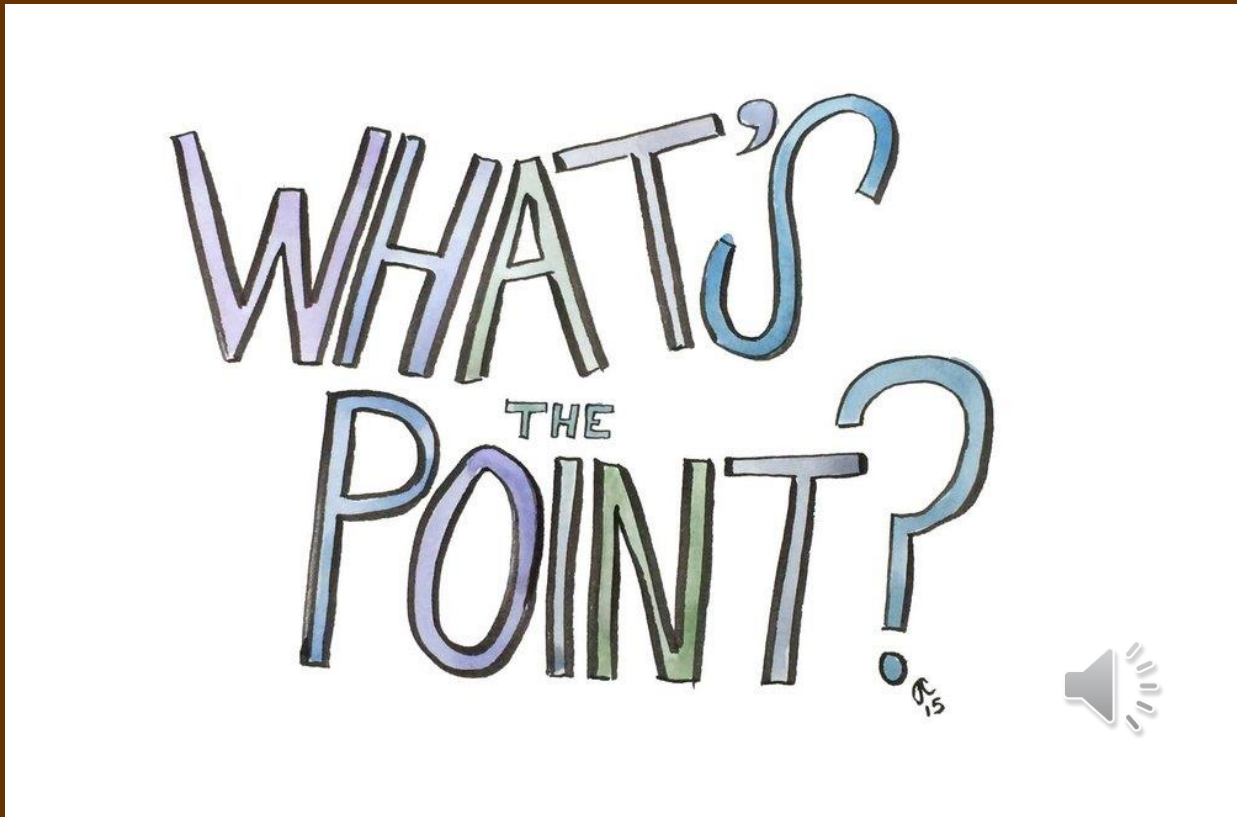

“For each petal on the shamrock
this brings a wish your way.
Good health, good luck, and
happiness for today and every
day.”
Irish Blessing

APPLICATIONS

OF

DERIVATIVES

Now that you know how to find derivatives, the obvious question is …



There are **many** reasons people use derivatives, which usually involve either:

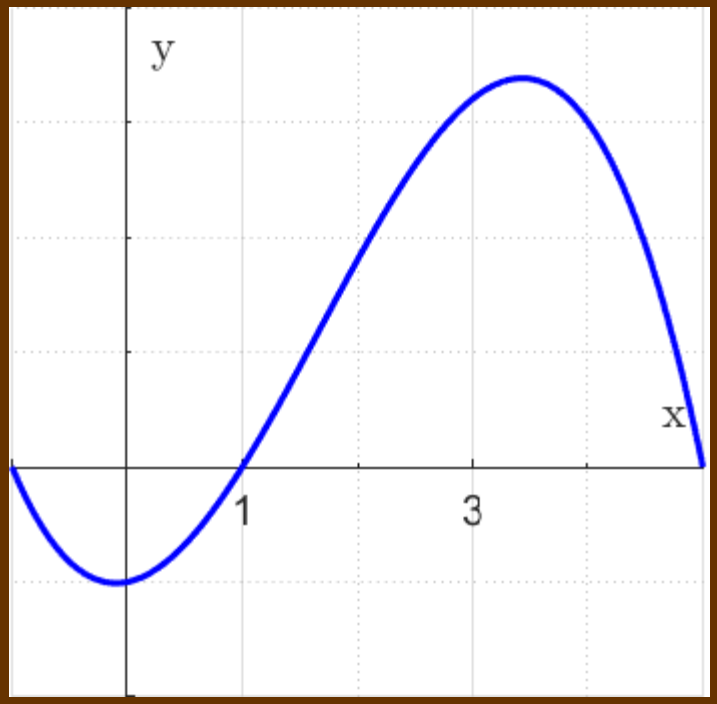
- how things are changing
- finding the most or least of something

The most common derivative applications involve **MOTION**.

Typically you are given a function $s(t)$ that describes the position of an object at a given time.

The **derivative** $s'(t)$ tells the **velocity** at any given time.

If $s'(t) = 0$, the object is at its highest (or lowest point).



Acceleration?

The **second derivative** $s''(t)$ tells the **acceleration**.

Typical questions …

- How high?

  Plug into the original function

- How fast?

  Plug into the derivative

- When is it at its highest point?

Set derivative = 0

- When will it hit the ground?

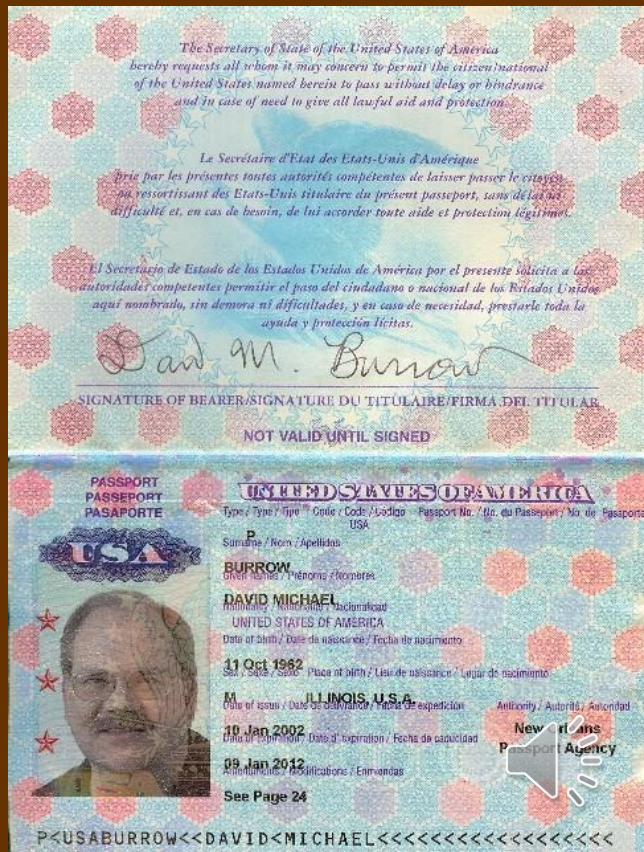
Set original = 0

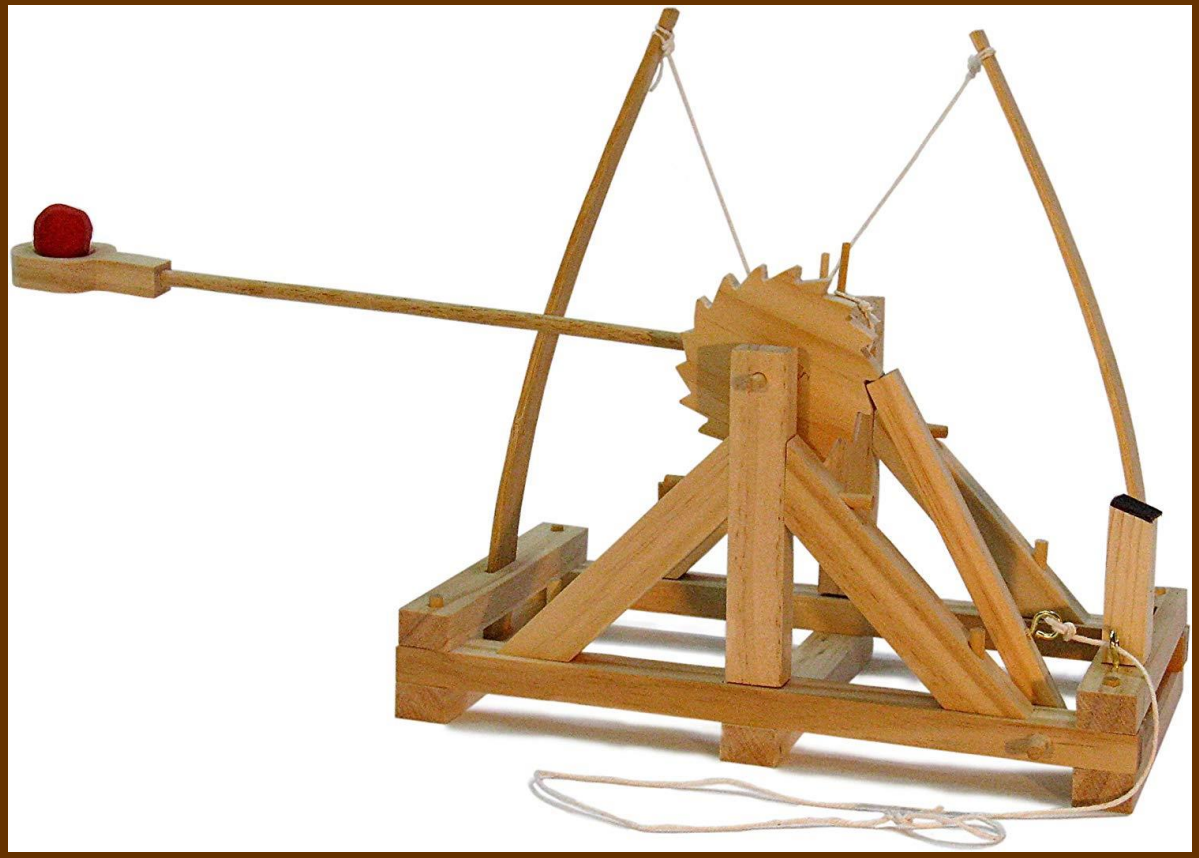
- What is the acceleration?

  Plug into 2nd derivative

  (often constant)

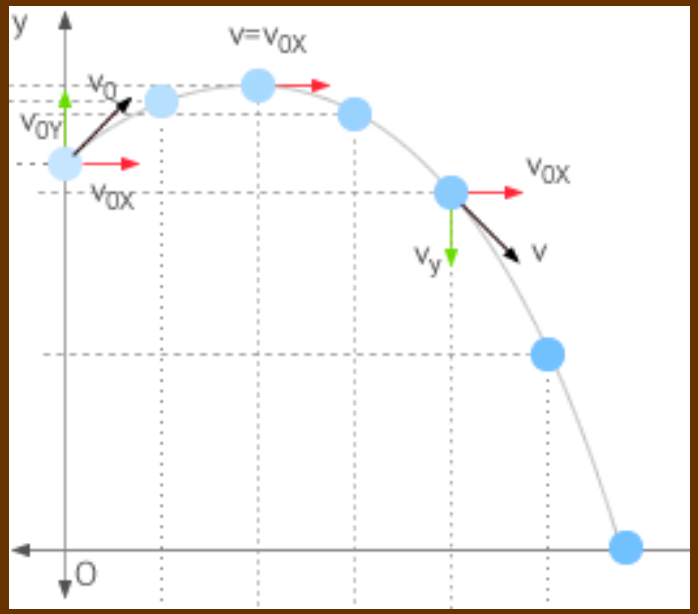
Mr. Burrow travels to Canada, but he forgets his passport, so he can’t return to the U.S. legally.





He decides to strap himself to a catapult and propel his body over the border.

When he does, at any given time, the height of his body is described by the function $s(t) = 48 + 32t - 16t^2$.



a. How fast is he moving after 1 second?

b. How fast is he moving after 2 seconds?

c. When is his body at its highest point?

d. How high is his body when he reaches his highest point?

e. How high is his body after 1 second?

f. When does he hit the ground?

g. How fast is he traveling when he hits the ground?

h. What is his body's rate of acceleration?

a. How fast is he moving after 1 second?

$s(t) = 48 + 32t - 16t^2$

$s'(t) = 32 - 32t$

b. How fast is he moving after 2 seconds?

$s(t) = 48 + 32t - 16t^2$

$s'(t) = 32 - 32t$

c. When is his body at its highest point?

$s'(t) = 32 - 32t$

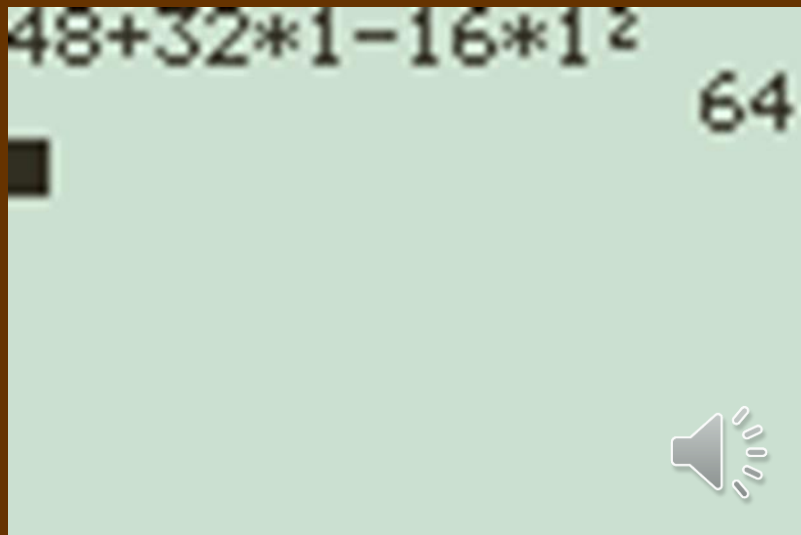
$32 - 32t = 0$

$32 = 32t$

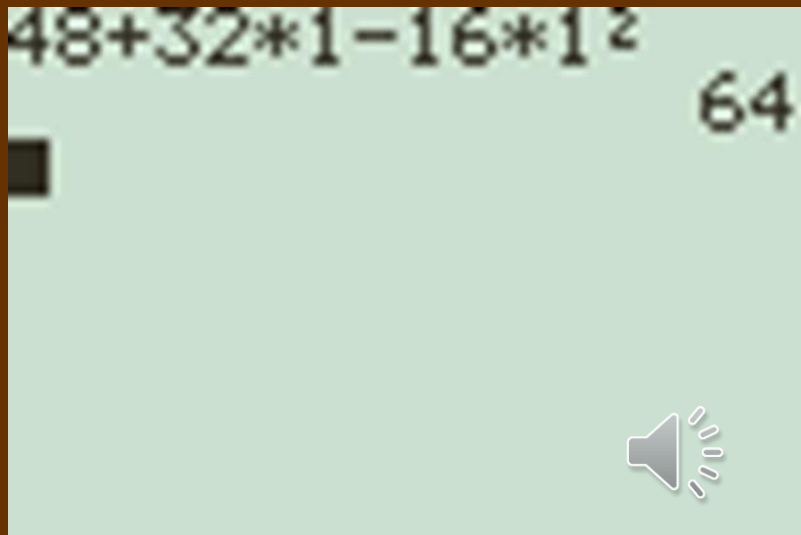
$1 = t$

d. How high is his body when he reaches his highest point?

$s(t) = 48 + 32t - 16t^2$

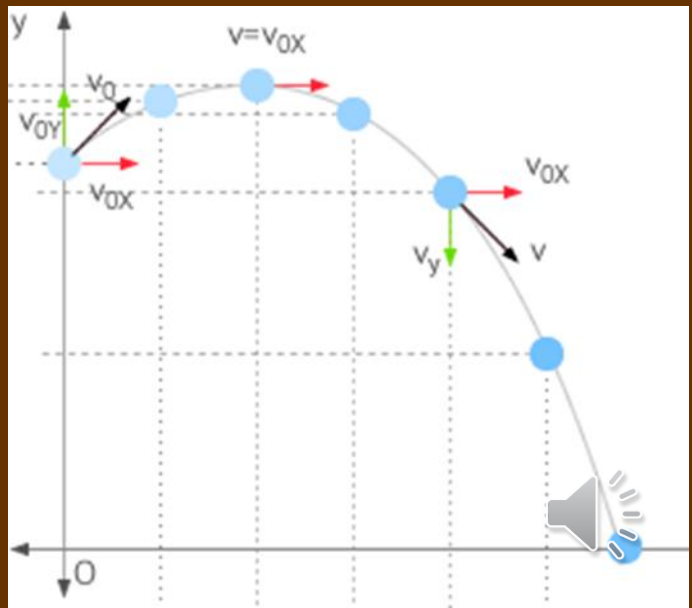


e. How high is his body after 1 second?



f. When does he hit the ground?

$$48 + 32t - 16t^2 = 0$$
$$3 + 2t - t^2 = 0$$
$$0 = t^2 - 2t - 3$$
$$0 = (t - 3)(t + 1)$$
$$\underline{\boldsymbol{t = 3}}$$



g. How fast is he traveling when he hits the ground?

$s'(t) = 32 - 32t$

h. What is his body's rate of acceleration?

$s(t) = 48 + 32t - 16t^2$

$s'(t) = 32 - 32t$

$s''(t) = -32$

One day when the trig class was measuring things outside the school, someone decided to climb one of the light towers by the baseball field.

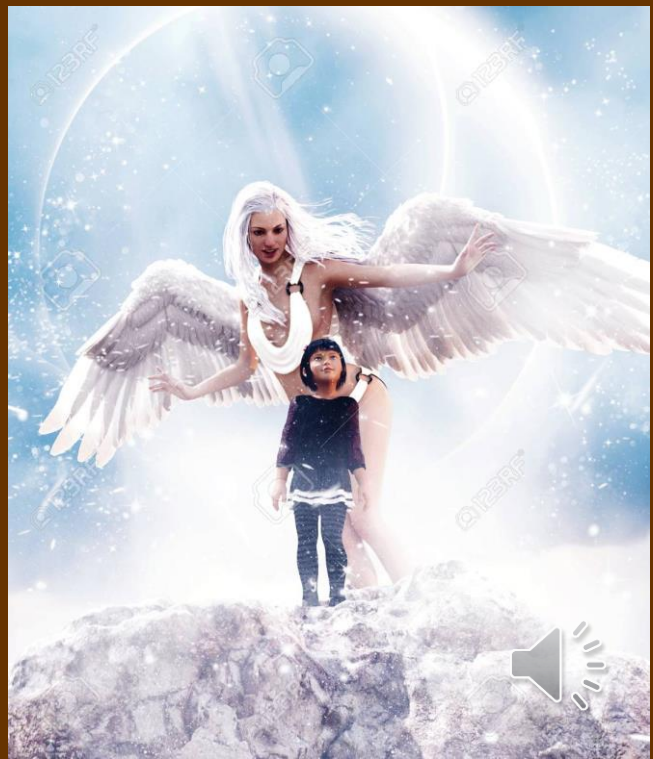
Unfortunately they fell off. As they fell to their death, their plunge was described by the function $s(t) = 80 - 16t^2$.

a. How long does it take before they hit the ground?

b. How fast are they traveling when they die?

c. What is the rate of acceleration?

d. If a guardian angel comes up and snatches them 2 seconds after they start to fall, how high will they be off the ground?

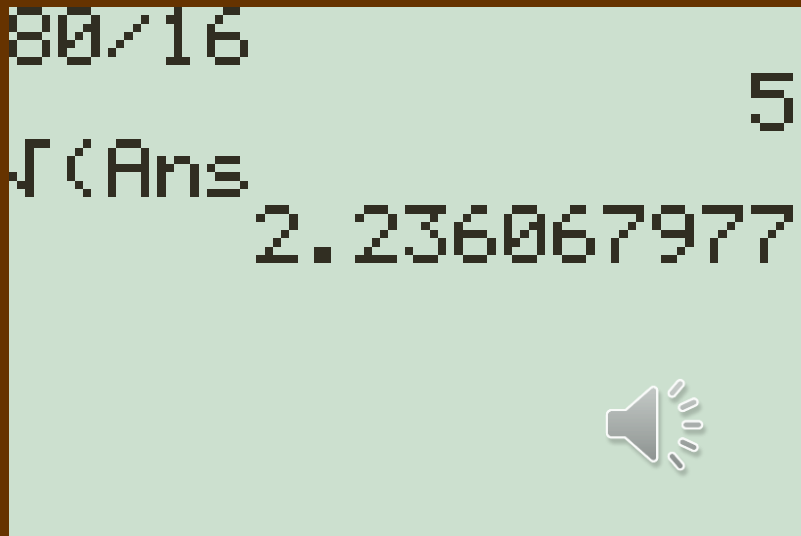


a. How long does it take before they hit the ground?

$s(t) = 80 - 16t^2$

$80 - 16t^2 = 0$

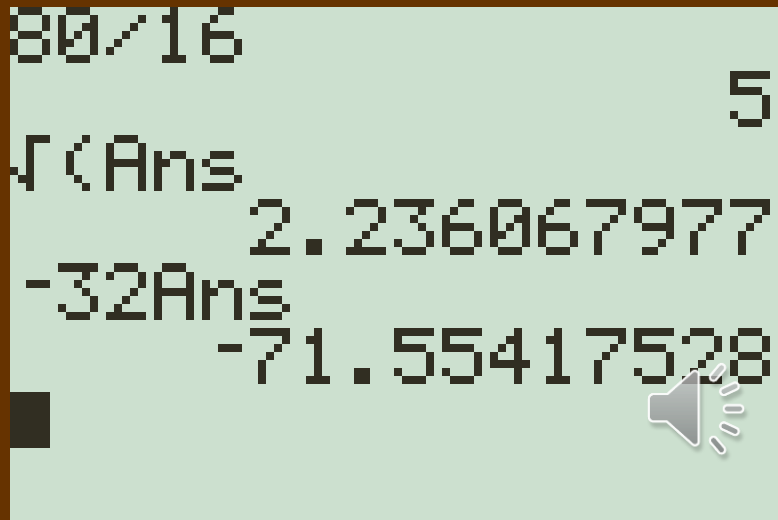
$80 = 16t^2$



b. How fast are they traveling when they die?

$s(t) = 80 - 16t^2$

$s'(t) = -32t$



c. What is the rate of acceleration?

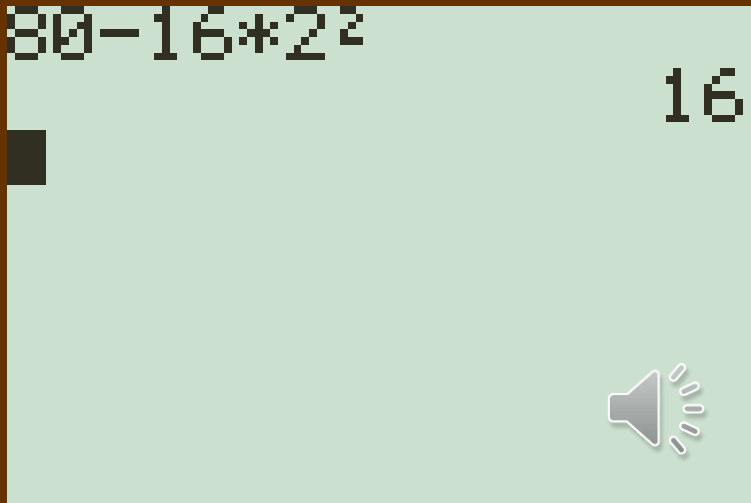
$s(t) = 80 - 16t^2$

$s'(t) = -32t$

$s''(t) = -32$

d. If a guardian angel comes up and snatches them 2 seconds after they start to fall, how high will they be off the ground?

$s(t) = 80 - 16t^2$



ORIGINAL FUNCTION

Plug in ➔ Position (how high?)

= 0 ➔ When it hits the ground

DERIVATIVE

Plug in ➔ Velocity (how fast?)

= 0 ➔ When is it at the highest point?

SECOND DERIVATIVE

Acceleration