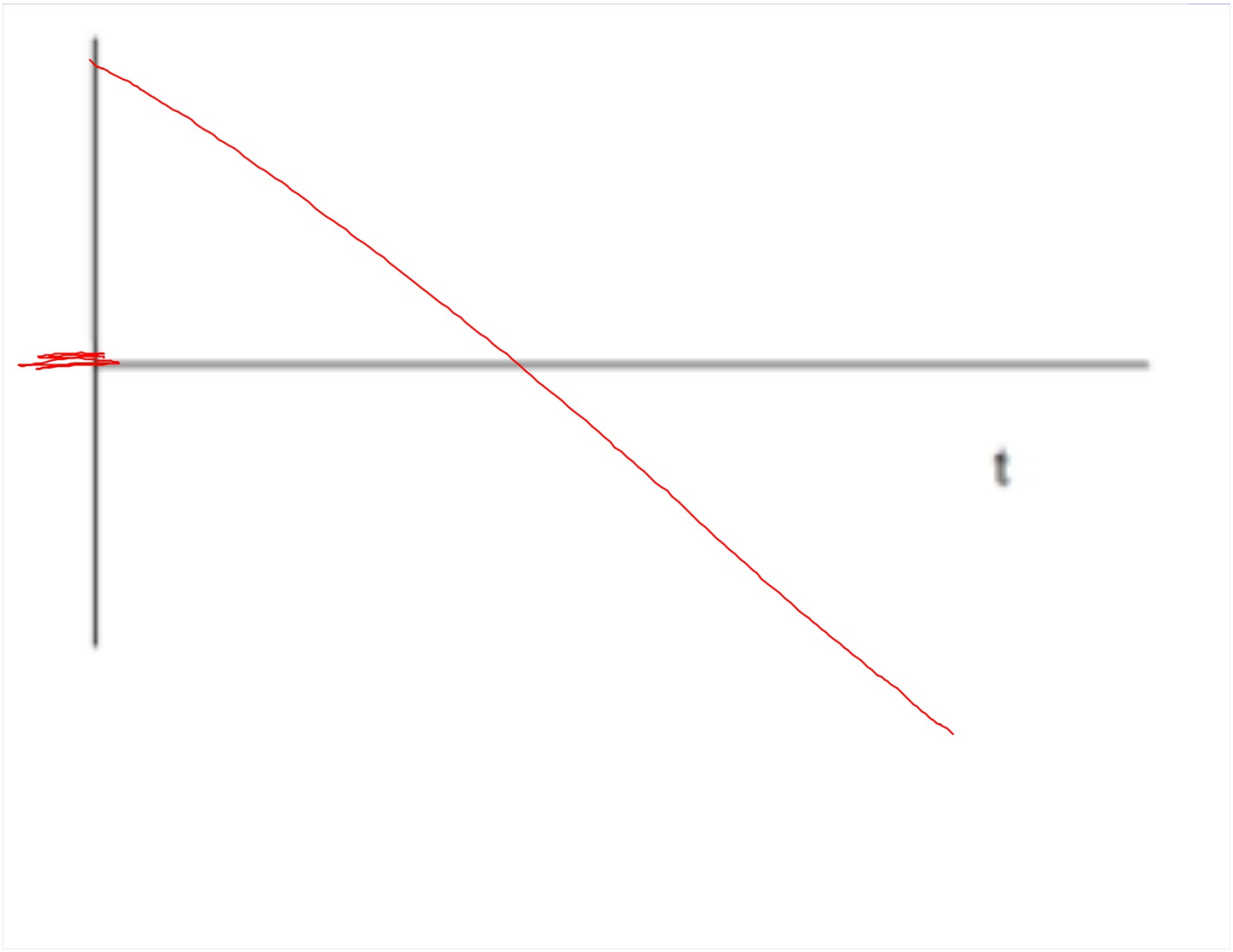
Do Now:

Draw the velocity-time graph for an object that is thrown straight in the air.

Graph the velocity from the time it is thrown until it hits the ground.

Assume that up is positive.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This Week:

M: Begin Free Fall Problems

T: Continue Free Fall Problems

W: Labs (Buggy Fancart and Falling man)

R: Review 1-D motion

F: Quiz

Quest:

Free Fall Questions: Due Thursday at 8:00 EST

Solutions Available Thursday at 8:01 EST

Vertical 1-D Kinematics

- Objects in "free fall."
- We neglect air resistance.
- There is only one force acting on objects.

Gravity!!!!!!!!

Gravity

- We often talk about gravity as a force.
- Formulas??
- Acceleration Due to Gravity.

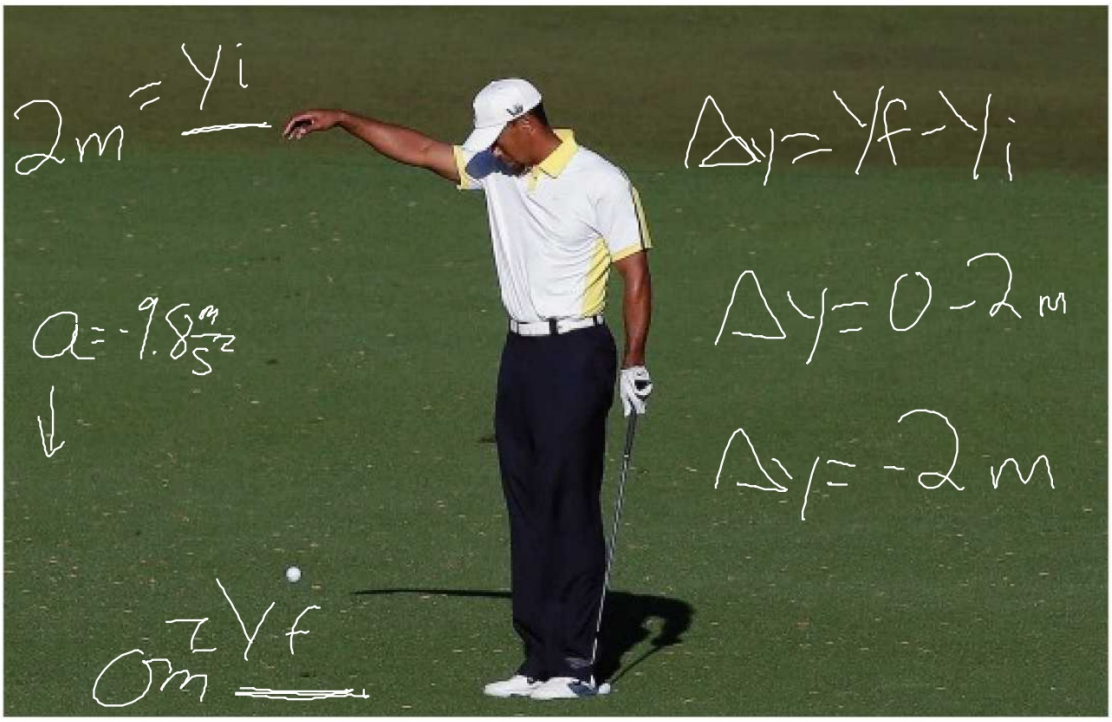
Gravity

- What goes up...
- Gravity makes things go faster, right?
- What's the value of the acceleration due to gravity.
- Is gravity constant????

$$a = g = -9.8 m/s^2$$

- Up is positive.
- Down is negative.
- Gravity "pulls" things downward.
- Acceleration dje to gravity is always the same *around* the Earth's surface.

Peak Height



Set Up Coordinates

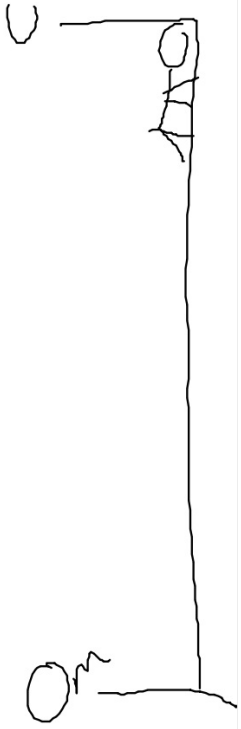
Justin Beiber is rock climbing. He falls off of the wall and hits the landing pad below 2.1 seconds later. How high up the wall was he?

K: $a = -9.8 \frac{m}{s^2}$, $t = 2.1\,s$, $V_i = 0 \frac{m}{s}$

U: Δy Eqns: $\Delta y = V_i t + \frac{1}{2} a t^2$

$\Delta y = \frac{1}{2}\left(-9.8 \frac{m}{s^2}\right)(2.1\,s)^2 = -21.609\,m$

$\Delta y = y_f - y_i$: $y_i = 21.6\,m$



A banana is dropped from the top of the Empire State Building, 443m from the ground. How fast it the banana going when it his the ground?

K: $a = -9.8\ m/s^2$, $\Delta y = -443m$, $V_i = 0\ m/s$

U: $V_f = ?$ Eqn: $V_f^2 = V_i^2 + 2a\Delta x$

$$\sqrt{V_f^2} = \sqrt{2a\Delta x} = \sqrt{2\left(-9.8\frac{m}{s^2}\right)(-443m)}$$

$$V_f = -93.2\ m/s$$

Direction Matters

Peak Height

- When an object is thrown upward, it slows down until it eventually stops, changes direction, and comes back down.
- At the peak height, the velocity is **zero**.
- Usually solve for displacement.

A can of coke is shot from a cannon from the ground (assume ground level) with an initial velocity of 24m/s. How high does the can go?

K: $a = -9.8\ m/s^2$, $24\ m/s = V_i$, $V_f = 0\ m/s$

U: Δy Eqns: $V_f^2 = V_i^2 + 2a\Delta y$

$$\Delta y = \frac{-V_i^2}{2a} = \frac{-\left(24\ \frac{m}{s}\right)^2}{2\left(-9.8\ \frac{m}{s^2}\right)} = 29.4\ m$$

A Volkswagen is launched from a catapult. If the car takes 5 seconds to reach peak height, what is the car's velocity when launched?

K: $a = g$, $t = 5\,s$, $V_f = 0\,m/s$

U: $V_i = ?$ Eqn: $V_f = V_i + at$

$-at \quad -at$

$V_i = -at = -(-9.8\,m/s^2)\,5 = 49\,m/s$

How long does it take the VW to land?
How fast is it going when it does?

Mirror Motion

- The velocity of launch is equal to the velocity of landing.
- Time going up equals time coming down.

Quadratic!!! Mr. Breish is shot out of a cannon straight into the air. He goes 43m into the air and then lands safely back on the ground. How long was he in the air?

K: $a = g = -9.8\ m/s^2$, $V_f = 0\ m/s$, $\Delta y = 43m$

U: t Eqn ~~$V_f = V_i + 2a\Delta y$~~ $V_f^2 = V_i^2 + 2a\Delta y$

$V_i = \sqrt{-2a\Delta y} = 29.0\ m/s$

$t_{A,C} = 5.92\ s$

A boat anchor is dropped from a cliff.
What is it's velocity after 4 seconds?

Tom Morello throws a guitar into the air with an initial velocity of 12.0m/s. How fast is it going after 1.3 seconds?