Announcements – 4 Sep 2014

1. Prayer

2. If you weren't here last time:
   - o Go to the course website!
     www.physics.byu.edu → Courses → Course websites → Physics 105
   - o Read the "How to get started" section at bottom of page; there are about 10 things you need to do ASAP
   - o Read the syllabus
   - o Look over the posted class notes from Tuesday
   - o Go to Max for calendar, warmup quizzes, reading assignments, homework problems, grade checking, etc.
   - o Warmup quizzes are due 15 mins before class
     - but you get 4 free warmups, so it's OK if you missed today's
   - o First HW was due last night
     - but you get 4 free late homeworks, so it's OK if you missed it

3. Practice Problems

4. A cappella anyone?

“Which of the problems from last night's HW assignment would you most like me to discuss in class today?”

Review

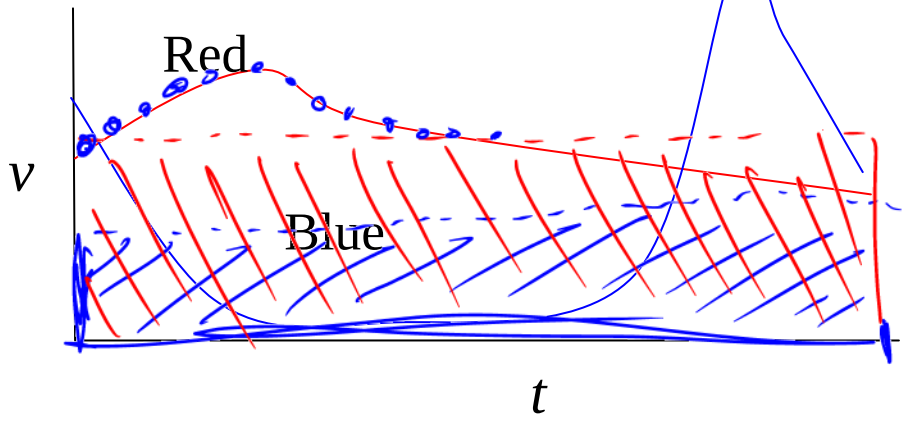
Position: where the object is. relative to origin

Displacement: change in position.

Velocity: rate of change of position

- **average** velocity: rate of change of position over some time interval, slope between two points of *x* vs *t* graph $v_{ave} = \frac{\Delta x}{\Delta t}$
- **instantaneous** velocity: rate of change at specific time, slope of tangent line at one point of *x vs. t* graph.

Clicker quiz: The following are $v(t)$ curves for two airplanes.



Which airplane flew the farthest?

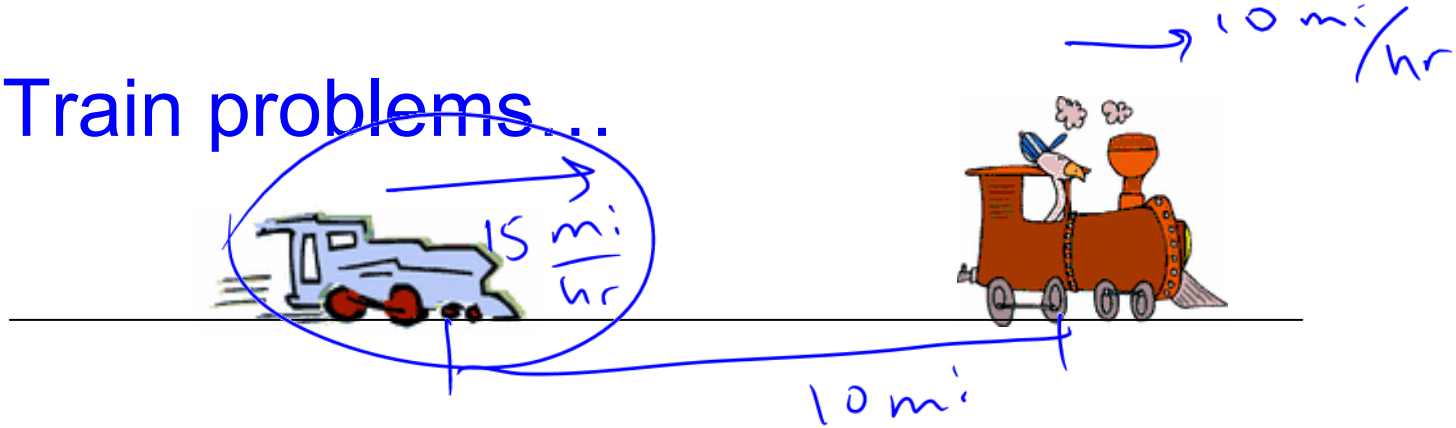
a. red

b. blue

Hint: estimate each one's <u>average</u> velocity

$$v_{ave} = \frac{\Delta x}{\Delta t} \longrightarrow \Delta x = v_{ave} \cdot \Delta t$$

Train problems…



A train leaves Provo for SLC at 8 am, going 10 mph. A second train leaves Provo for SLC at 9 am, going 15 mph. It is 40 miles to SLC. Will the 2nd train catch up before SLC? If so, where?

Hint: think about *relative* velocities.

→ how fast does the gap close?

Steps: 10 miles

- What is the initial gap? (How much of a head start does the first train have?)
- How fast does the gap close? 5 mi/hr
- How long does it take the gap to close? 2 hr
- Where are both trains after this amount of time? 30 miles from Provo

Answer: yes 2nd train catches up, 10 miles from SLC

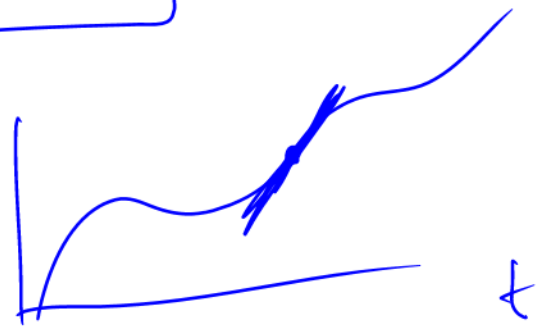
Acceleration

is **rate of change of velocity**: slope of *v* vs. *t* graph

average acceleration: $a_{ave} = \frac{\Delta v}{\Delta t}$

Compare $v_{ave} = \frac{\Delta x}{\Delta t}$

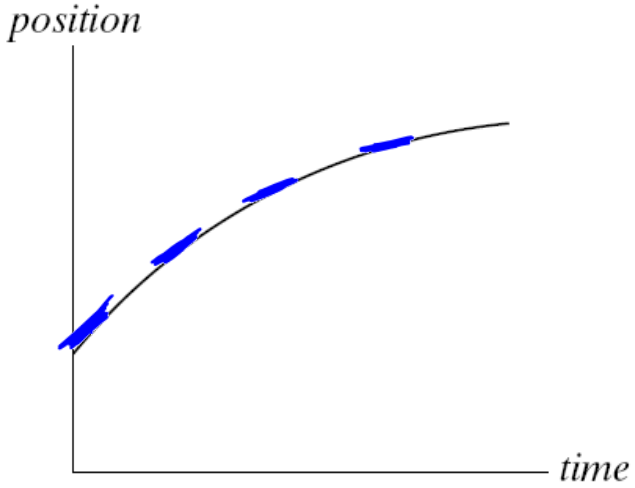
instantaneous acceleration



Acceleration has the same relationship to velocity as velocity does to position

Clicker quiz

A train car moves along a long straight track. The graph shows the position as a function of time for this train. The graph shows that the train:



a. speeds up all the time.
b. slows down all the time.
c. speeds up part of the time and slows down part of the time.
d. moves at a constant velocity.

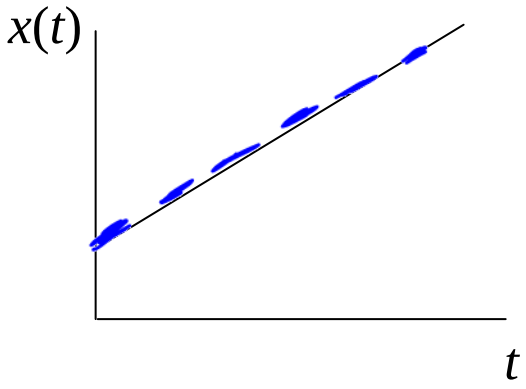
Hint: What would the velocity vs. time graph look like?

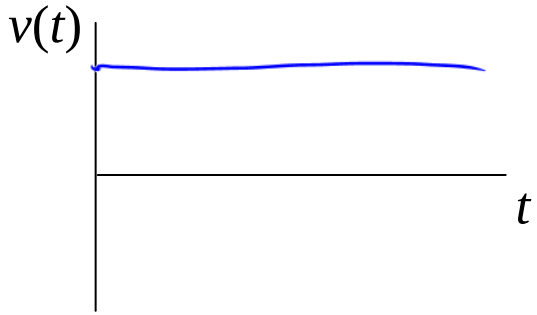
Problem: There two different objects move as plotted.

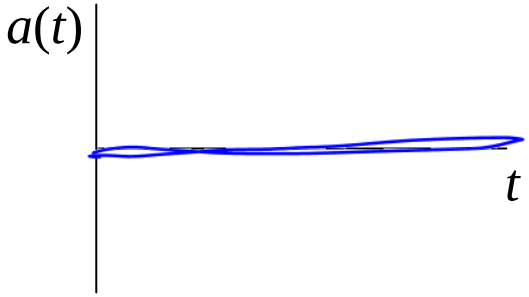
a. Describe each motion with words.

b. Figure out what the $v(t)$ and $a(t)$ graphs must look like for the two cases.

(1)







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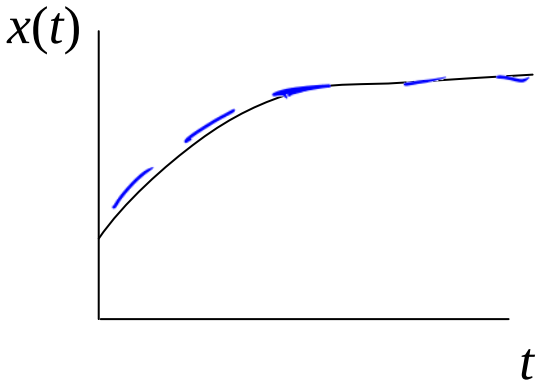
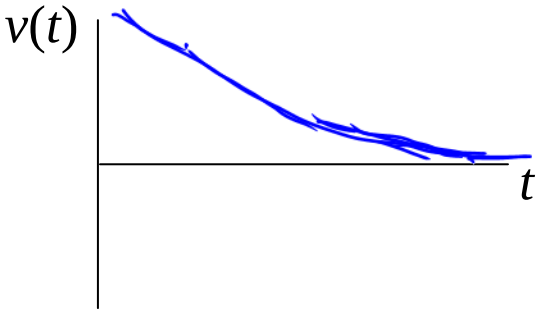
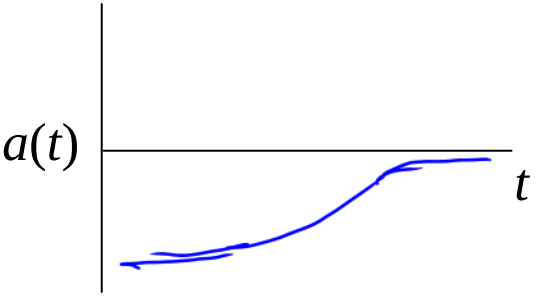






Some accelerations

Accel. due to earth's gravity: "*g*"

Altitude (km)[a]	g (m/s^2)
1 000	7.33
2 000	5.68
3 000	4.53
4 000	3.70
5 000	3.08
6 000	2.60
7 000	2.23
8 000	1.93
9 000	1.69
10 000	1.49
50 000	0.13

Near surface $g \approx 9.8$ m/s^2
(ignoring air resistance)

$a_y = -g$

Dr. John Stapp, rocket sled (1951): -45 *g*'s

- Fast sports cars: 0.8-1.1 *g's*
- Extreme amusement park rides: 3-5 *g's*
- Fighter planes: 5-9 *g*'s
- Laundry in my washing machine's spin cycle: 100+ *g's*

Demo: Penny & Feather

Keeping track of signs:

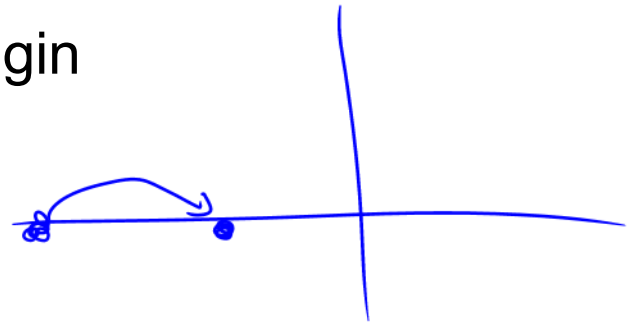
Position, displacement, velocity, and acceleration have a direction, sometimes given by a **sign** (+/-) and sometimes by a **description** (left, right, north, south, etc.).

What do we mean by +/- position?

Being on the + or - side of the origin

What do we mean by +/- displacement?

Has *shifted* to the right or left

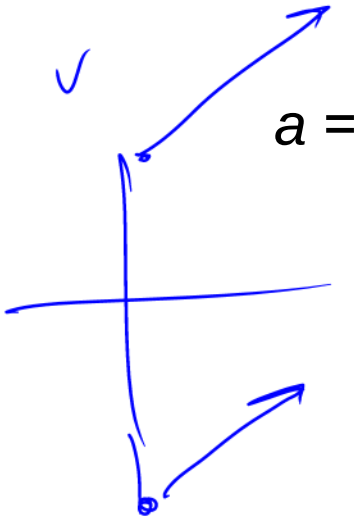


What do we mean by +/- velocity?

Moving in the + or - direction

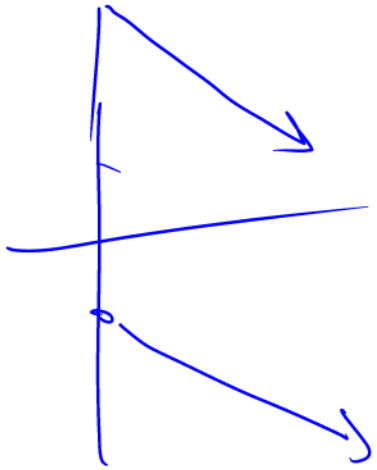
What do we mean by +/- acceleration?

The velocity is changing + vs. −



a = +: if v = positive… more positive! speeds up

if v = negative… less negative! slow down



a = –: if v = positive… less positive slow down

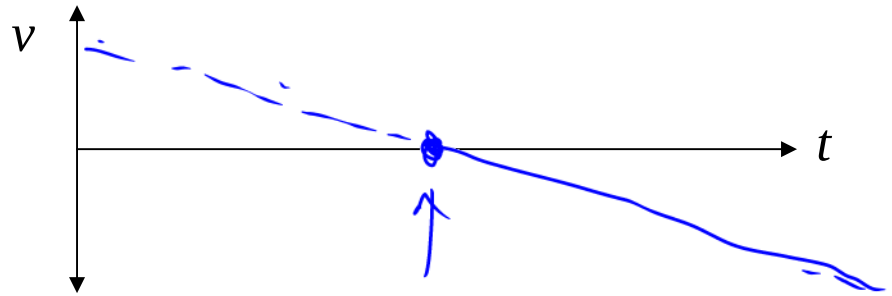
if v = negative… more negative speeds up

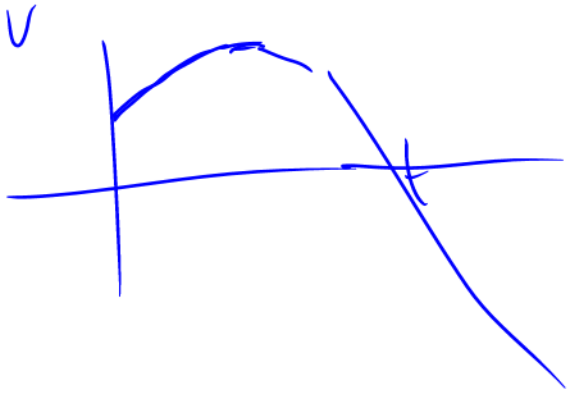
Clicker quiz

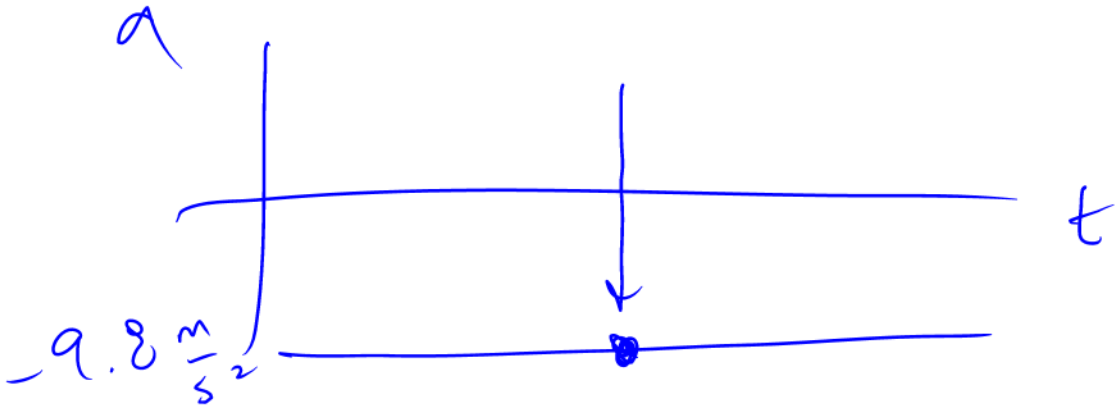
You are throwing a ball straight up in the air. At the highest point, the ball's

a. velocity and acceleration are zero.
b. velocity is nonzero but its acceleration is zero.
c. acceleration is nonzero, but its velocity is zero.
d. velocity and acceleration are both nonzero.

Hint: what does $v(t)$ graph look like, starting right after it leaves your hand?







From warmup: A ball tossed vertically upward rises, reaches its highest point, and then falls back to its starting point. During this time, the acceleration of the ball is always

a. in the direction of motion
b. opposite its velocity
c. directed downward
d. directed upward

From warmup: If I throw a ball straight up into the air, we say the ball is an object in "**free fall**"

a. on its way up
b. on its way back down
c. both on its way up and on its way back down.

"Kinematic Equations" for *constant* acceleration

x_0, v_0 = initial position, velocity
x_f, v_f = position, velocity after some time t (often I leave off the "f")

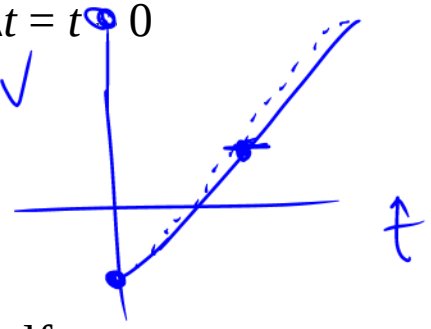
$$v_f = v_0 + at$$

$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t}$

Derivation:

Use definition of a_{ave}, with $\Delta v = v_f - v_0$ and $\Delta t = t - 0$

Notice that $v(t)$ is a straight line



$$v_{ave} = \frac{v_0 + v_f}{2}$$

Derivation:

Since $v(t)$ is a straight line, average must be halfway between the beginning and ending velocities

$$x_f = x_0 + v_0 t + \frac{1}{2} a t^2$$

Derivation:

$$v_{ave} = \frac{x_f - x_0}{t - 0}, \quad \text{also} \quad v_{ave} = \frac{v_0 + v_f}{2}$$

Set equal, plug in $v_f = v_0 + at$: $\frac{x_f - x_0}{t} = \frac{v_0 + (v_0 + at)}{2}$

Solve for x_f

$$v_f^{\,2} = v_0^{\,2} + 2a\Delta x$$

Derivation:

Combine two previous boxed eqns to get rid of *t*, write $x_f - x_0$ as Δx, solve for v_f^2

From warmup quiz

Ralph asked me a question the other day. Consider a car accelerating forward. Its acceleration is 1.8 m/s^2. During the first second, the car accelerates from 0 to 1.8 m/s. Ralph thought that since the velocity at the end of the first second is 1.8 m/s, the car would travel 1.8 m during that first second. But someone told him that the answer is actually 0.9 m. Can you help Ralph understand why? Don't just say, "Because the formula in the book says so."

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

"Think-pair-share"

- Think about it for a bit
- Talk to your neighbor, find out if he/she thinks the same as you
- Be prepared to share your answer with the class if called on

Clicker: I am now ready to share my answer if randomly selected.

a. Yes

Note: you are allowed to "pass" if you would really not answer.

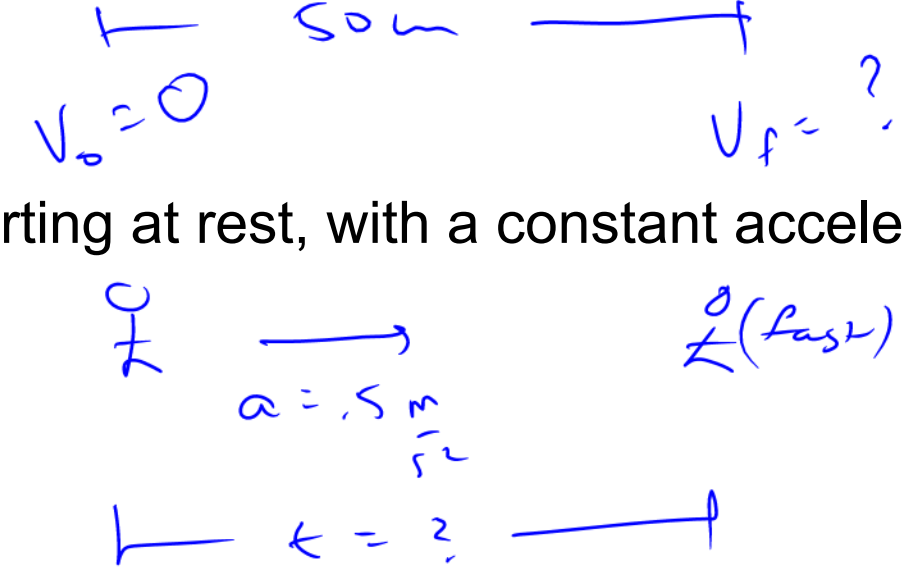
Worked Problem

A sprinter runs the 50 m dash starting at rest, with a constant acceleration of 0.5 m/s^2. Find:

a) Her final velocity

b) Her average velocity

c) The time it took



Problem Solving Tip:
Always draw a **picture**!

Problem Solving Tip:
Look for equations that contain the given information, not the variable you're looking for.

Picture

Equations → $V_f = V_0 + at$

Algebra → $V_{ave} = \frac{V_f + V_0}{2}$

Numbers → $x_f = x_0 + v_0 t + \frac{1}{2} a t^2$

Think → $V_f^2 = V_0^2 + 2a\Delta x$

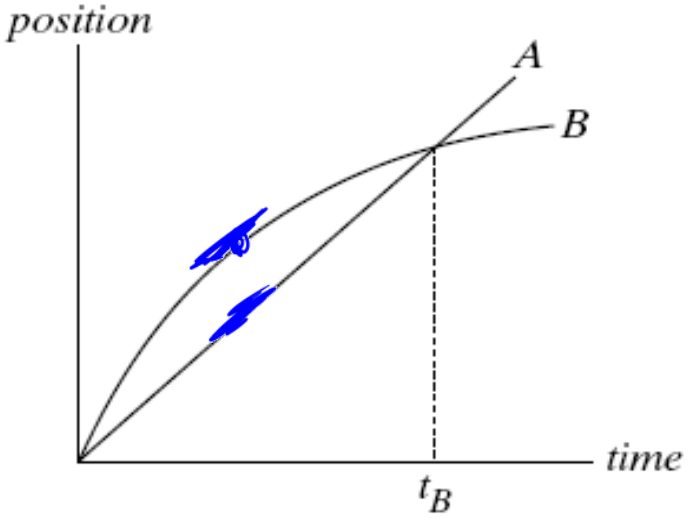
$V_f = \sqrt{0^2 + 2(.5\ \frac{m}{s^2})(50m)}$

$= 7.07\ m/s$

$= \frac{7.07 + 0}{2}\ \frac{m}{s}$

Clicker quiz

This graph shows position as a function of time for two trains running on parallel tracks. Which is true:



a. At time t_B, both trains have the same velocity.
b. Both trains speed up all the time.
c. Both trains have the same velocity at some time before t_B.
d. Somewhere on the graph, both trains have the same acceleration.
e. More than one of the above

Things to remember

If you are new:

Go to class website

www.physics.byu.edu → Course websites → 105 (Colton)

Read “How to get started”

Everyone:

- Next homework is due Monday 11:59 pm
- Do next reading assignment
- Do next warmup quiz
- Bring clicker to class
- Etc.