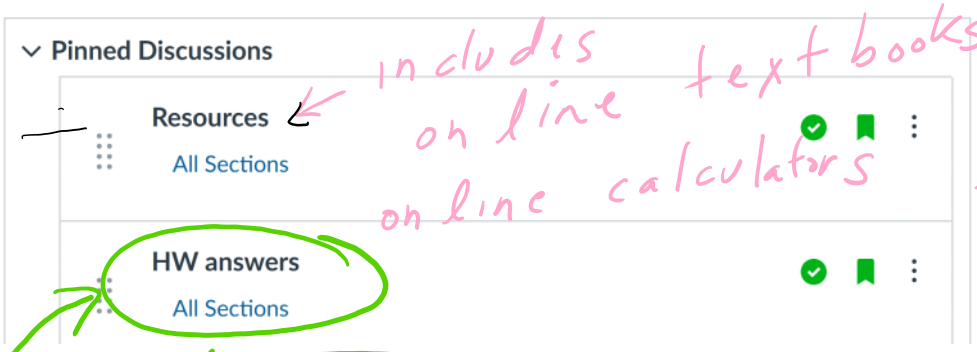


includes online textbooks, online calculators } use these on HW & exams as long as you cite them (web url)

Homework will normally be due on Wednesdays. Each problem will be worth 5 points. Some HW problems will be graded, while others will only be checked for completion. **THUS YOU SHOULD CHECK YOUR ANSWERS.** Answers to almost all problems (both even and odd) are available in the back of your textbook. **After your HW has been turned in, if you would like feedback or a more complete answer for a particular problem, please respond to this post.** If you have questions before HW is due, please e-mail me (include 2560 in subject line) or come to office hours.

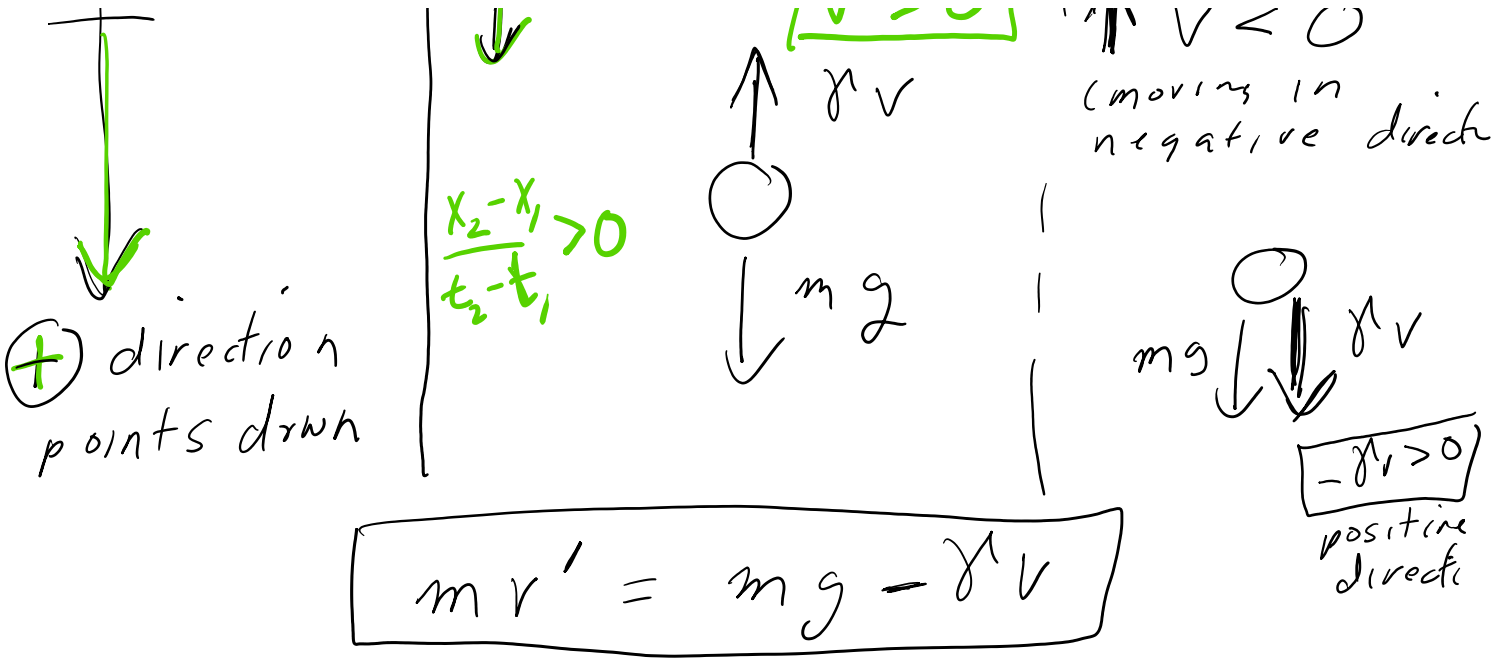
For the next 3 Mondays, we will try out asynchronous lectures. Thus we will not have a regular lecture for the next 3 Mondays (see video webpage for videos that you should watch instead). However,

↑ link syllabus (top of page)

- you should come to class to work on HW on these Mondays.
- While this is not required, I will be available to answer any questions.
- We can also have breakout rooms where students work together on a particular problem (you can invite me to the breakout room if you have questions).
- People learn more and retain more knowledge by actively working with others.
- This would be good practice for the real world, where many jobs have an online collaborative component.

Please watch the week 1 videos this week. I will talk more about videos and quizzes this Friday.

1.1 Ball



$$mv' = mg - \gamma v$$

EX: $m = 10$ m/s, $\gamma = 2$

$$v' = 9.8 - \frac{1}{5}v$$

Equilibrium sol'n = constant sol'n

$\longleftrightarrow$ $v(t) = k$ $\Longleftrightarrow$ $v'(t) = 0$ for all t

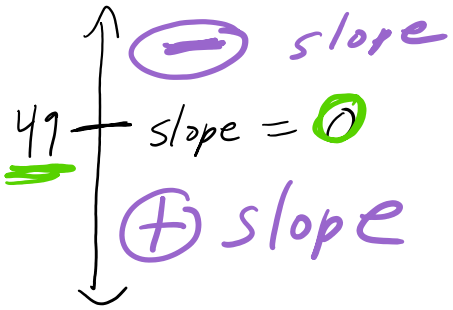
$\longleftrightarrow$ (horizontal line)

To find equil soln $v' = 0$

$0 = 9.8 - \frac{1}{5}v \Rightarrow v = 49$

Direction Field = draw small portions of tangent line

$v' = 9.8 - v/5$



$v' = 9.8 - v/5$

slope depends only on v and not t

$\boxed{v(t_0) > 49} \Rightarrow$ ⟶ $v = 49$

$\Rightarrow$ long term behavior

$t \to +\infty$, $v \to 49$

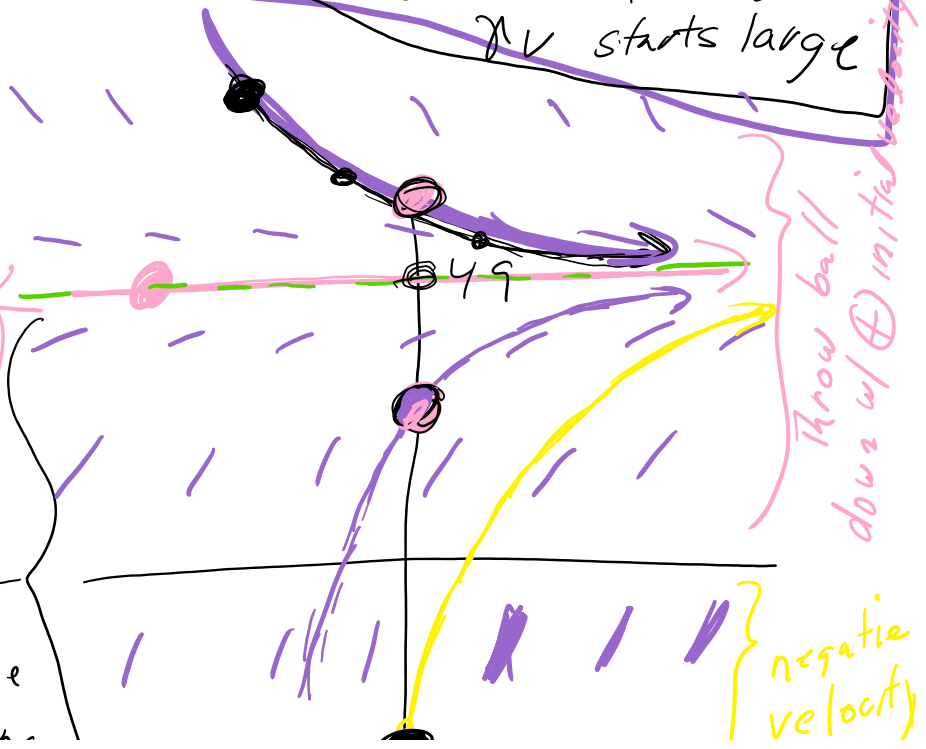
speed of ball gets slower $\Leftarrow$ Air resistance dominates since γv starts large

$mv' = mg - \underbrace{\gamma v}_{\text{large}}$

$v > 49$

constant velocity

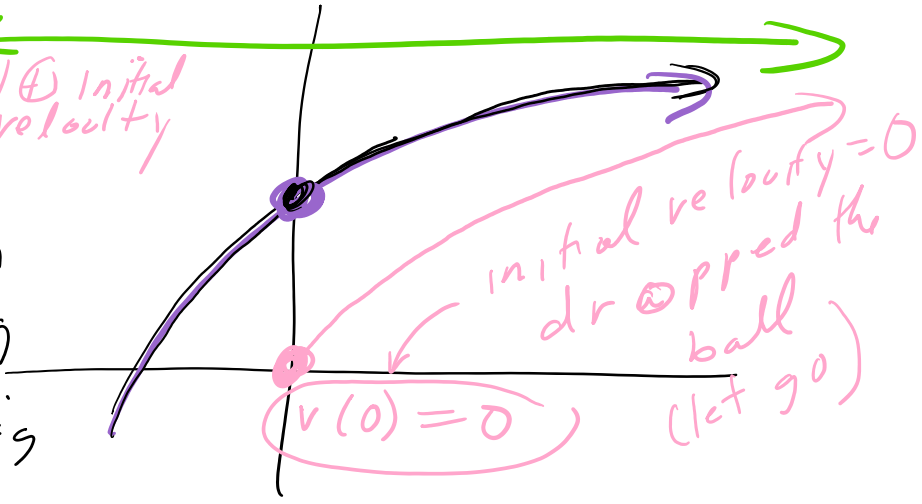
$v(t_0) = 49 \Rightarrow v(t) = 49$ for all t



slope is positive

slope is positive but decreasing

redraw



threw the ball down w/ ⊕ initial velocity

$0 < v(0) < 49$

positive direction

ball is falling

speed is increasing

as $t \to \infty$ $v \to 49$

$mv' = mg - \underbrace{\gamma v}_{\text{small}} \Rightarrow$ gravity dominates $\Leftrightarrow$ speed increases

$v(0) < 0$

$t \to \infty, v \to 49$

$v(0) < 0$

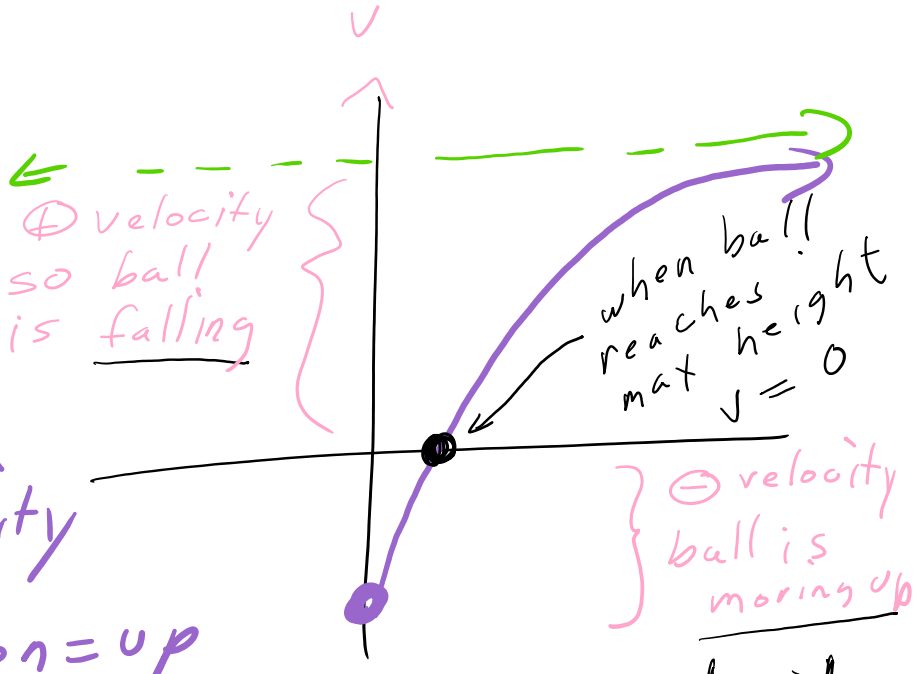
$\Rightarrow$ negative velocity

negative direction = up

$\Rightarrow$ the ball is thrown up w/ speed $|v(0)|$

$\Updownarrow$

negative velocity



negative velocity

long term behavior

as $t \to +\infty$, $V(t) \to 49$ m/sec

1.2 = 2.2 Solve $\frac{dv}{dt} = 9.8 - \frac{v}{5}$

1.2 = 2.2 : Separate variables to turn the problem into a calc 1 problem

If you don't like fractions, get rid of them

$$5\,dt\left(\frac{dv}{dt}\right) = \left(9.8 - \frac{v}{5}\right)(5)\,dt$$

$$\frac{5\,dv}{49 - v} = \frac{(49 - v)}{49 - v}\,dt$$

did not distribute dt since want to separate variables

$$\int \left[\frac{5}{(49 - v)}\right] dv = \int dt$$

$\int \frac{1}{49-v}\,dv$

$-5\ln|49-v| = t + C$

check integration by taking derivative

or use u substitution let $u = 49-v$, $du = -dv$

Solve for v

$\frac{-5\ln|49-v|}{-5} = \frac{t}{-5} + \frac{C}{-5}$

$\ln|49-v| = -\frac{1}{5}t + C$ ← sloppy

$e^{\ln|49-v|} = e^{-\frac{1}{5}t + C}$

$|49-v| = e^{-t/5 + C}$

$= \left(e^{-t/5}\right)\left(e^{C}\right)$

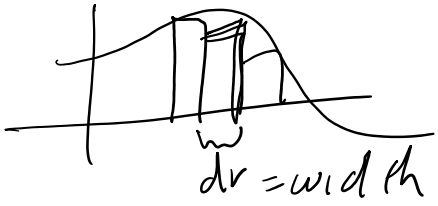
$C \overset{??}{=} \frac{C}{-5}$ is a constant since C is constant

sloppy. Should it

This is how a calc 1 problem

$\int f(v)\,dv$

height · width



dv should never be in denominator multiply by dv (or dt)

We will let C swallow constants

$$|49 - v| = Ce^{-t/5}$$

since e^c is a constant

(sloppy. Should've used same variable constant to mean 2 different things but we will be sloppy

$$49 - v = \pm Ce^{-t/5}$$

$$-49 + v = -Ce^{-t/5}$$

$$\boxed{v = Ce^{-t/5} + 49}$$ sol'n

as $t \to \infty$ $\quad v \to 49$

C depend on initial values