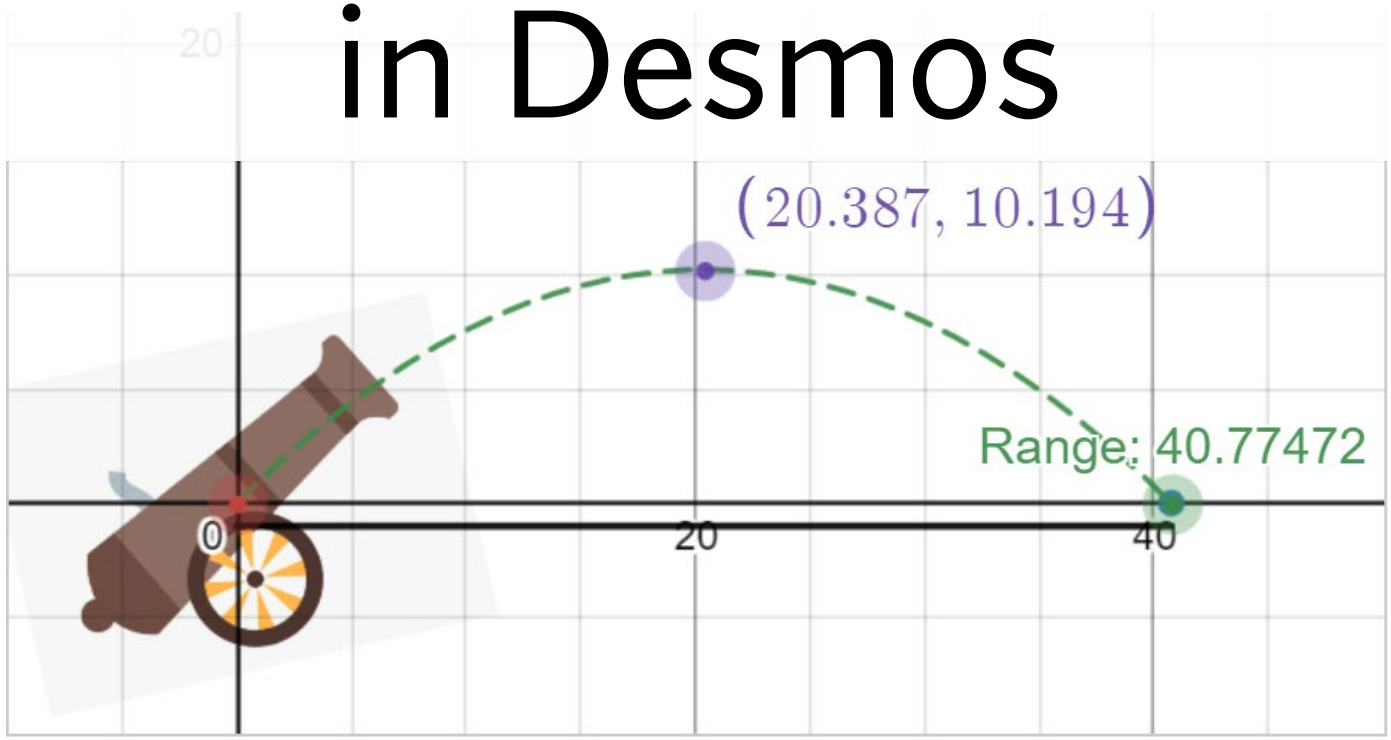
Kinematics Adventures in Desmos



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22 - 25 November
Tāmaki Makaurau | Auckland NZ

Motivation

- Trying out new features in Desmos
  - We've done some interesting things with desmos already that also map into algebra/ calculus/ and eng. math classes that we already teach
- Historically difficult topic to teach
  - Early in the course & students may have never seen physics before
  - Concepts such as a=0 (but there's always gravity?)
- COVID
  - More and more have to be agile, recent lockdown had <1 day notice
  - Difficult to introduce the 'active' component of activities

Teaching Context

First Semester	Second Semester
Physics – Classical Mechanics (5 streams of 35 students)	Calculus
Algebra	Physics - Electricity & Magnetism
Academic Literacies	Intro to Engineering
Programming	Problem Solving

Classroom Pods of 5 / Online

The Problem – 1-dimensional kinematics

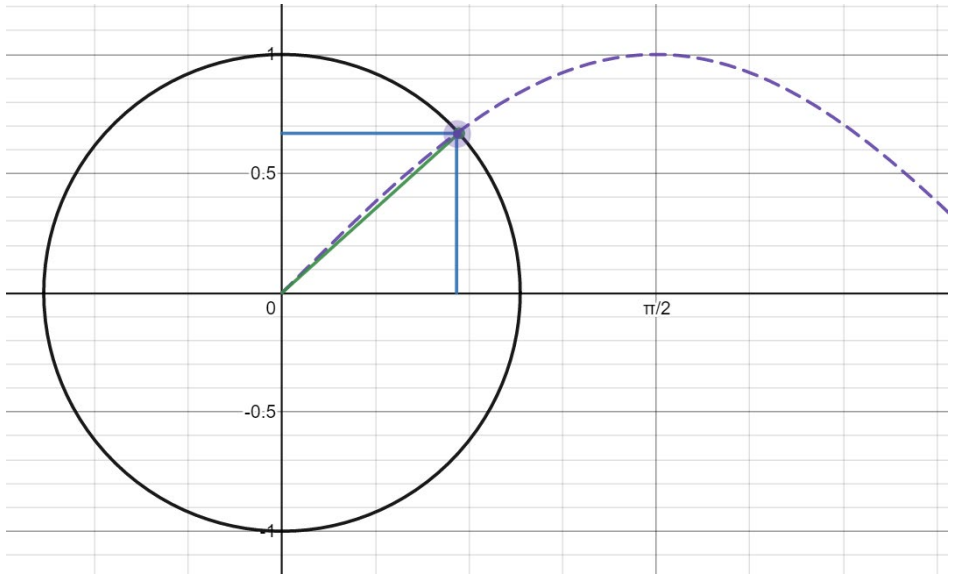
$$v_2 = v_1 + a\Delta t$$

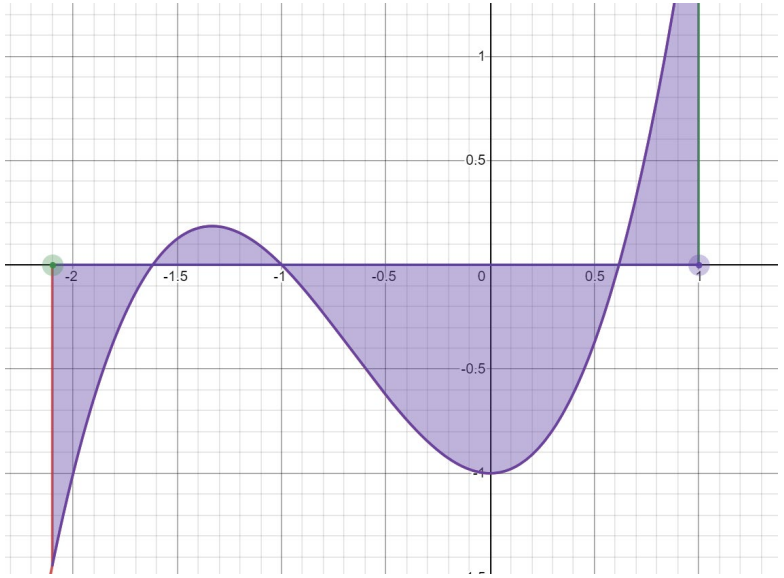
$$\Delta x = v_1 \Delta t + \frac{1}{2} a \Delta t^2$$

$$v_2^2 = v_1^2 + 2a\Delta x$$

Regular Desmos

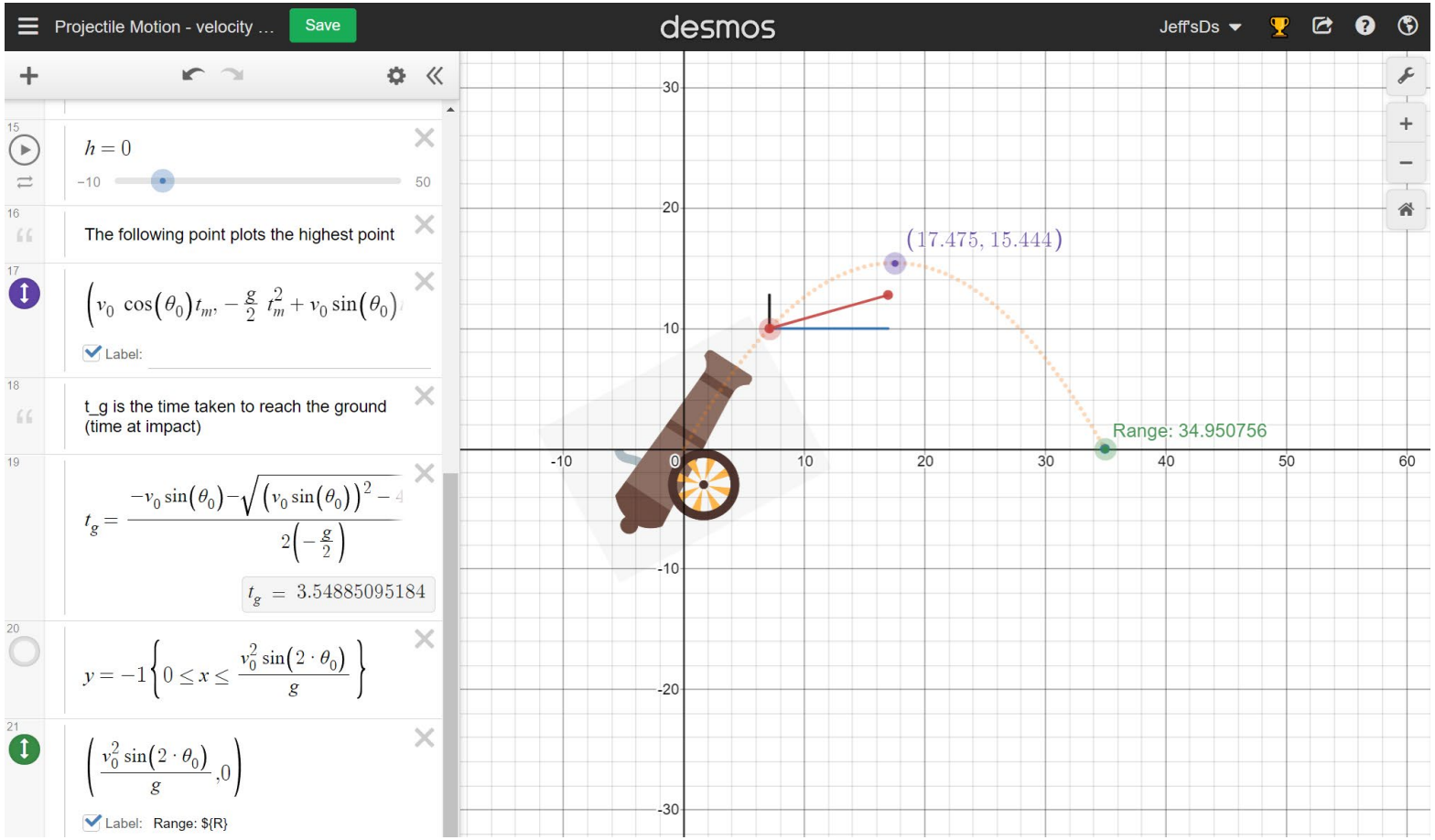
- Brilliant teaching companion





- Link to sine wave generator
- Link to area calculation

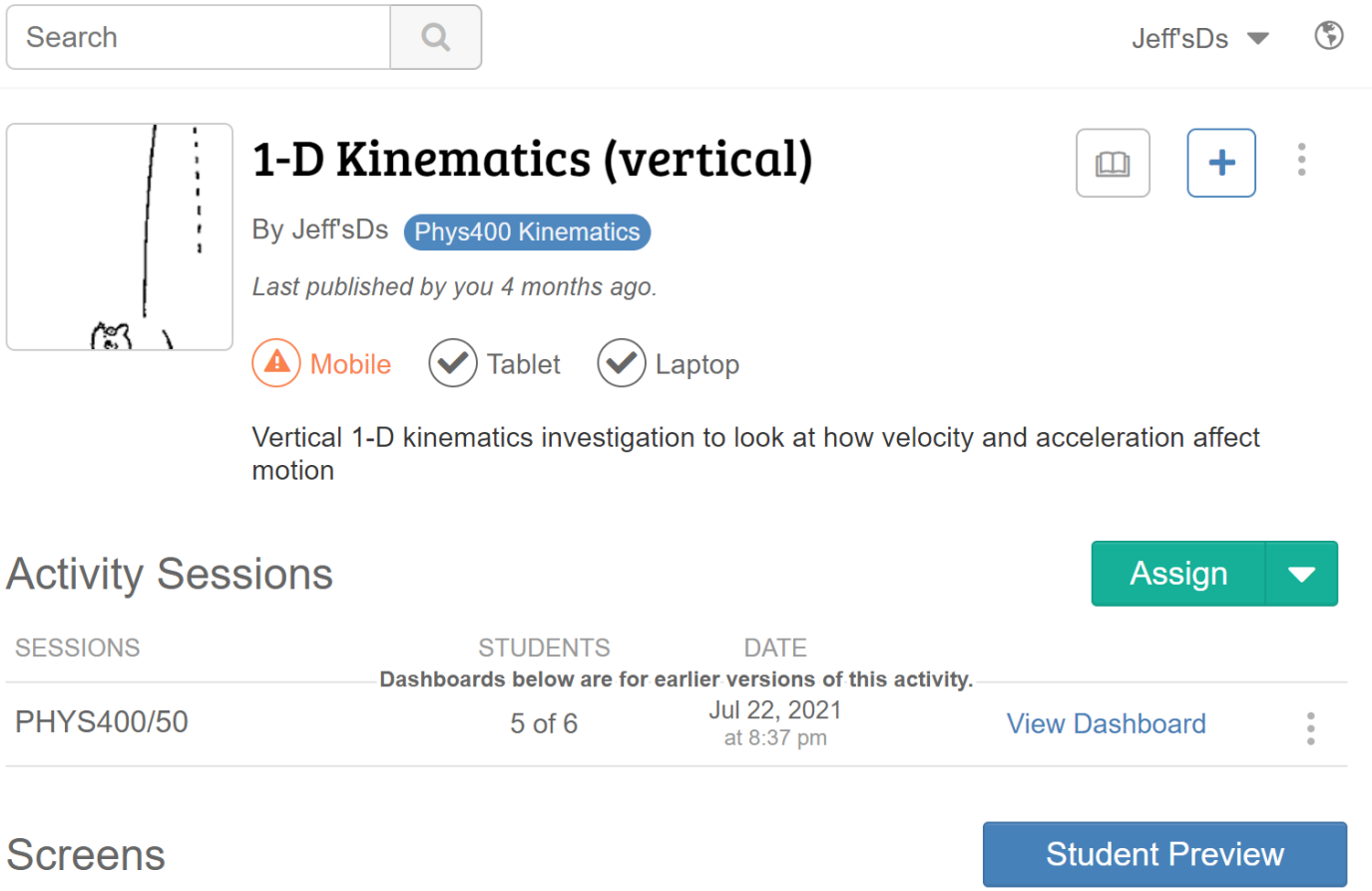
…however it can be confusing



- [Link to 2D projectile motion example]

Advanced Desmos

- teacher.desmos.com
- Supports teacher/classroom views
- Feedback from students can come to the teacher
- Students can be assigned work and complete it in their own time
- This activity was done in realtime in the classroom



1-D kinematics: demonstration (link)

Estimate how high you can throw

How fast can you throw a ball (straight) up?

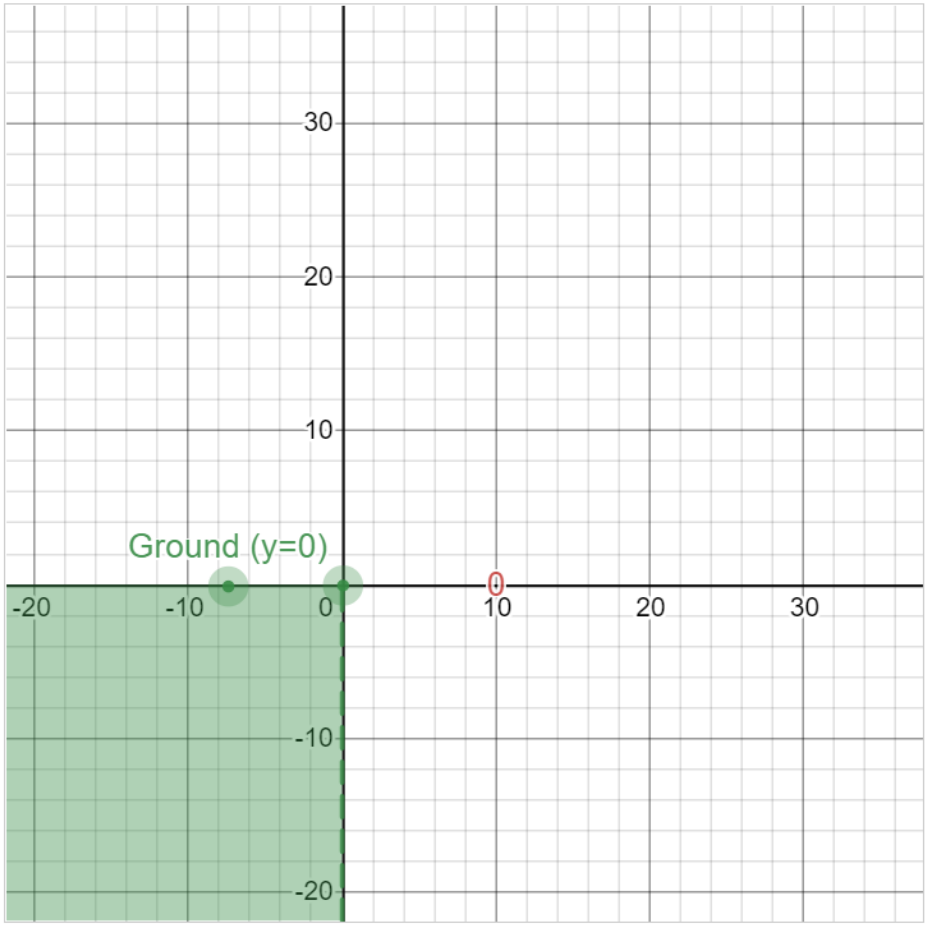
Write your number in the box. (This will be v_1 in meters per second.)

Estimate how high it will go, then click submit.

Submit

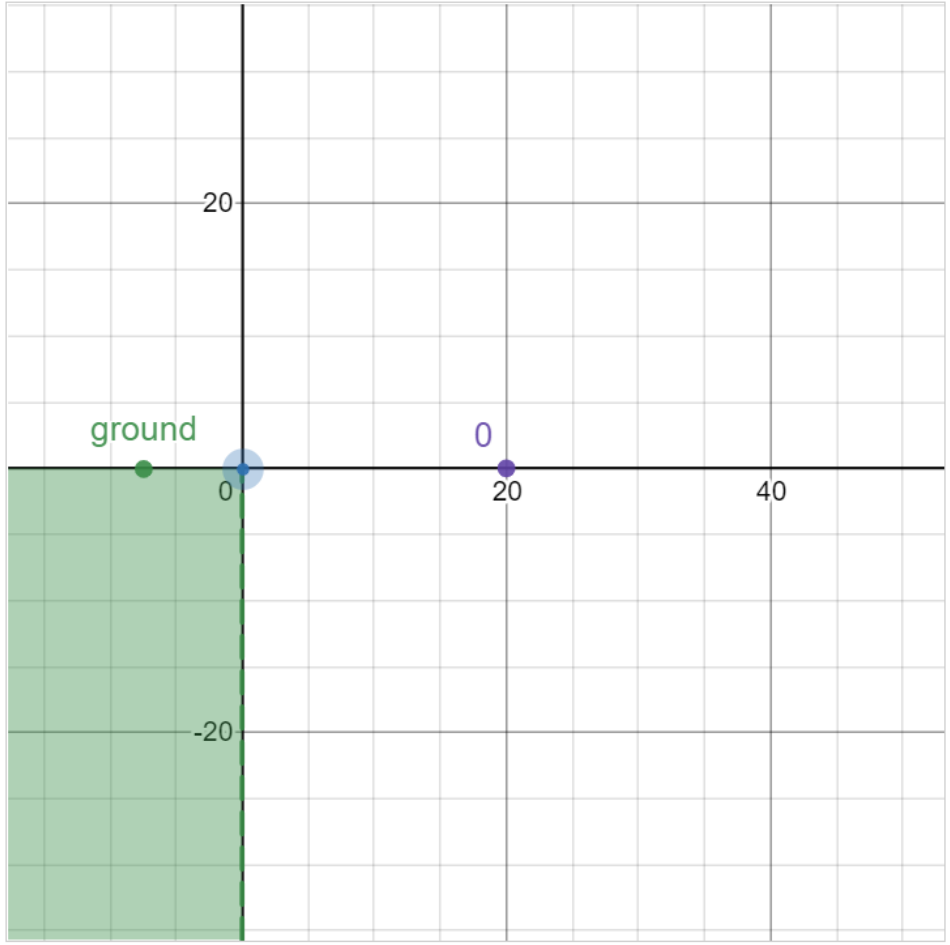
The vertical displacement is displayed on the graph.

Click 'edit my response' to reset. Input a new velocity and estimate again.



Screen 3 of 6

What happens with negative velocity?



Input a negative number for your initial velocity,

$v_1 =$

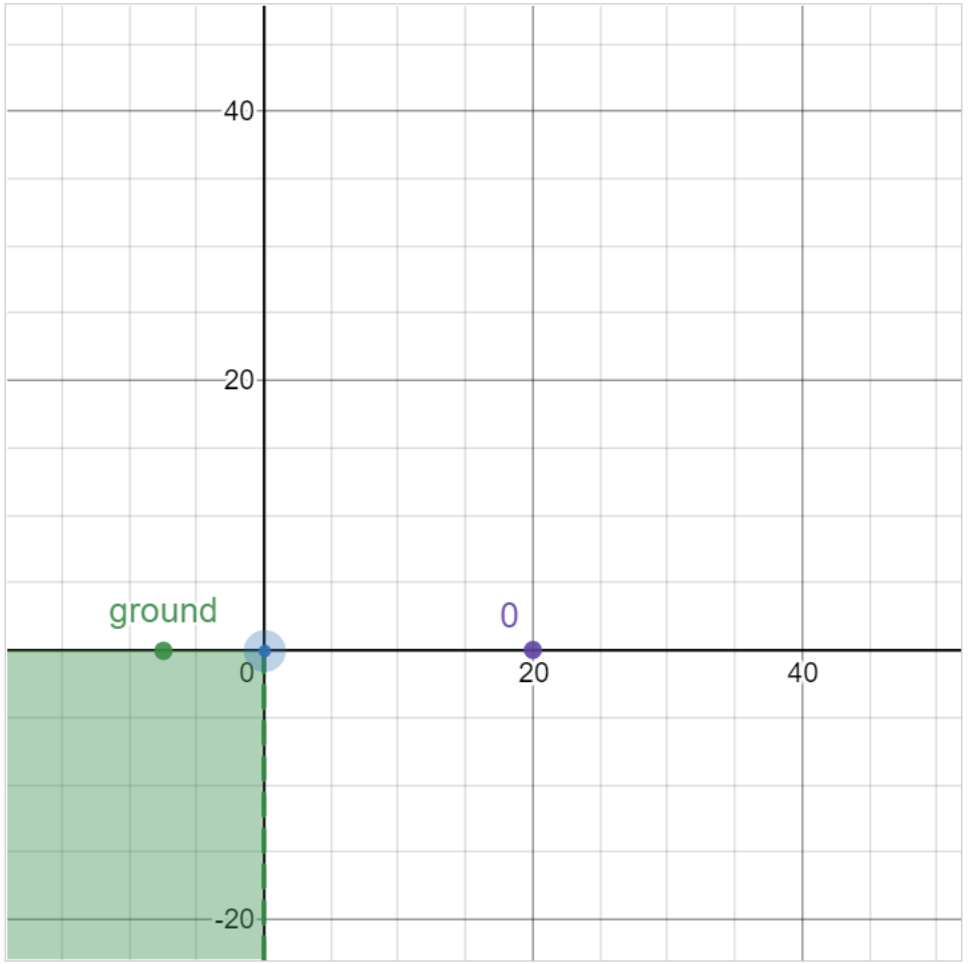
Submit

(Click 'edit my response' to reset.)

What is the difference when you use a negative velocity?

Screen 4 of 6

Change the acceleration



Acceleration due to gravity is $g = -9.8 \ \frac{m}{s}$.

What 'direction' does gravity work?

Try a different value for $g =$

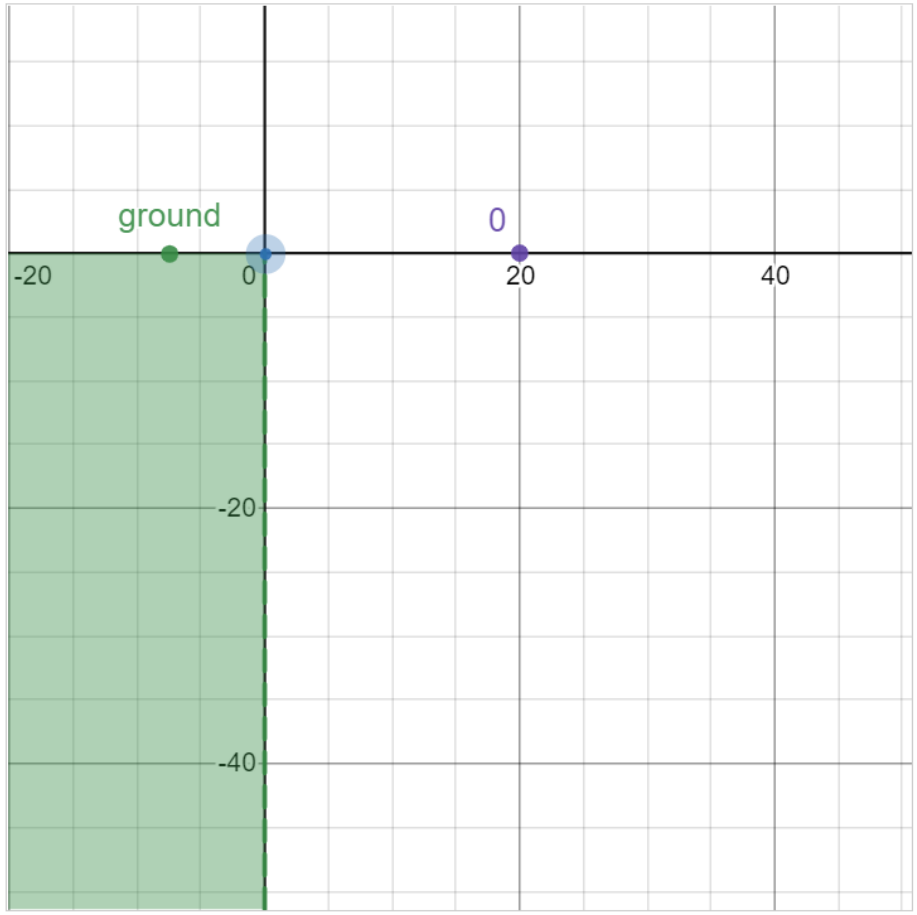
Enter an initial velocity $v_1 =$

Submit

What happens with a positive acceleration? Try a small positive number.

Screen 5 of 6

Freefall?



How can you simulate dropping an object off the cliff?

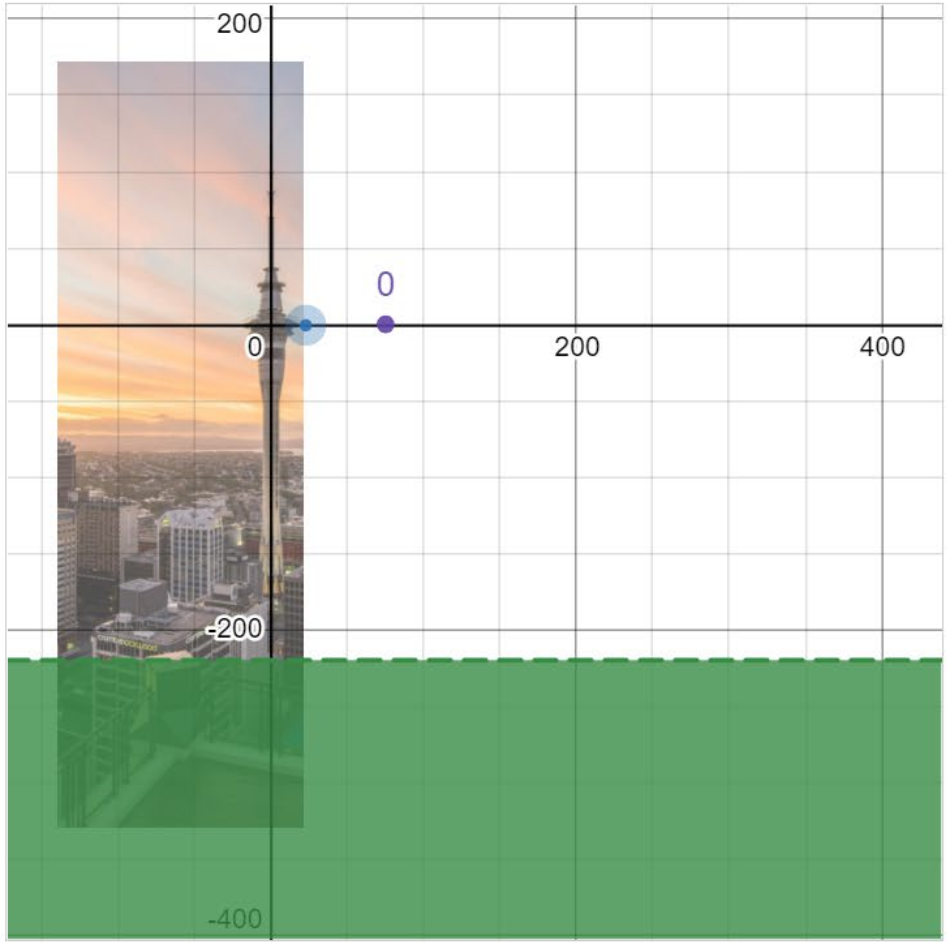
$a_g =$

$v_1 =$

Submit

(a_g means acceleration due to gravity)

Screen 6 of 6



The observation deck of the Sky Tower is 220 m above street level.

Calculate how long a dropped coin will take to fall.

What initial velocity will you use? $v_1 = ?$

Submit

time to fall, $t = ?$

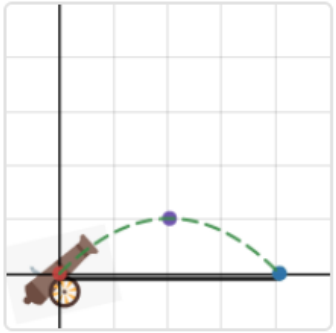
Submit

2-D Range activity (link)

1 Projectile motion

Vertical and horizontal motions are independent of each other in projectile motion, and this characteristic can be used to predict the range of a projectile. (Recall that the vertical motion is under the influence of gravity.)

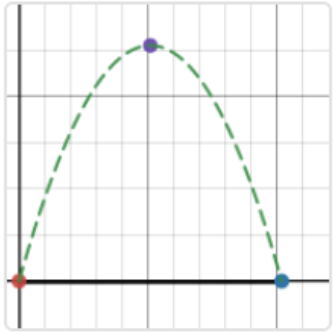
2 1. What is the ideal angle for…



The initial velocity v_0 of the canon is held constant.

f(x)

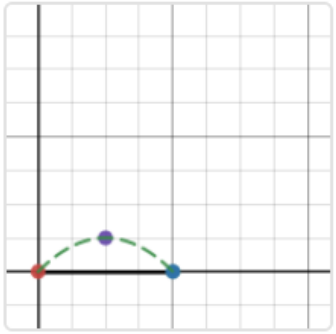
3 2. Does speed matter? Initial…



Keeping the initial angle A, constant, change the initial velocity

f(x)

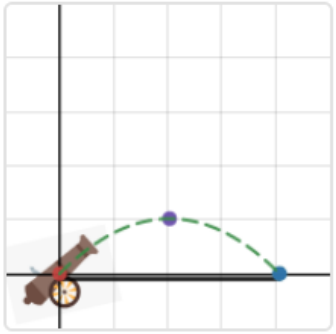
4 3. Gravity



The lunar astronaut Alan Shepherd played golf on the Moon

f(x)

5 4. x-coordinate of maximum …



What do you notice about the x-coordinate of maximum height

teacher.desmos.com

Benefits

- Discussion
- Students go at their own (groups' own) pace
- iteration

Difficulties

- Another widget to master
- *Computation Layer* is new
- At the mercy of the tech / static once 'published'
- ?

What do the students say?

Positive +	Less Positive −
• it was easy to learn, by seeing the motion of the projectile visually	• but it was somewhat difficult to know how to use Desmos
• I've used Desmos in my other classes so it was helpful	
• Desmos is very helpful in regards to visually viewing the activity, despite not being able to come on campus due to COVID–19 restrictions.	

Conclusion

- Students & Lecturers found it helpful ☑
- We'll iterate and do it again next year ☑
- Create a 2-D vector activity ☐
- Thanks & Questions
- I'll post links in the chat

Survey Questions Asked

As part of course feedback the students were asked the following two questions in relation to this activity.

For kinematics & projectile motion there were accompanying activities using Desmos:

1. Was it easy to follow along with the Desmos activity?
2. Would you recommend a Desmos activity for future students when learning about projectile motion?