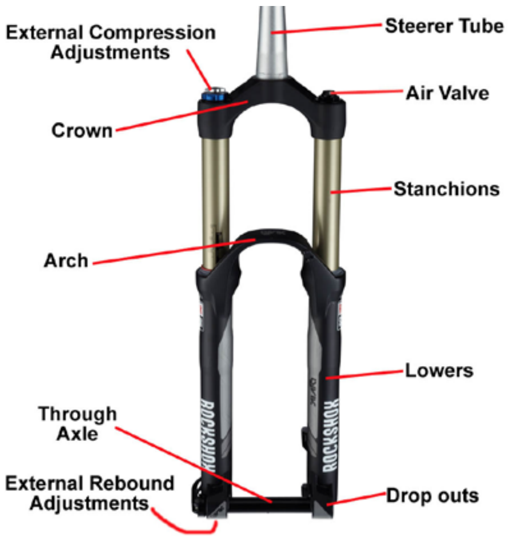
What are some *<u>driving</u>* *questions* you might examine about a bike shock?

What are some *<u>models</u>* might you produce with a bike shock?



Identify a situation where a bike shock might be compressed.

Watch the following video: Bike Shock Intro (video)

How would you model this data?

If you were modelling the compression of a bike shock, **What information would be necessary? What information would be unnecessary?**

How would you choose to represent the data in a table and a graph?

Imagine that you are braking and apply your hand brakes simultaneously, what happens to the front suspension?
Or, if you are stopping more abruptly, what happens to the front suspension?

A downward force, in Newtons, is a part of this system.

Think about the information that is necessary to model this mathematically. Two particular pieces of information are of interest. One would be the independent variable and the other would be the dependent variable.

If you were recording these two pieces of information in the metric system of measurement, how would you record them and their units?

What would be the best units for the <u>independent</u> variable?

What would be the best units for the <u>dependent</u> variable?

How will you obtain these measurements from the video?

Good, if you obtained the **correct units** on the previous page, you are coming to understand the situation we are about to model.

In the video you collected some data with a coil shock in your units of measurement. Enter your data in the following table and then graph your data in Desmos.

x_1	y_1

Before graphing your data answer these questions:

Is this data a function?

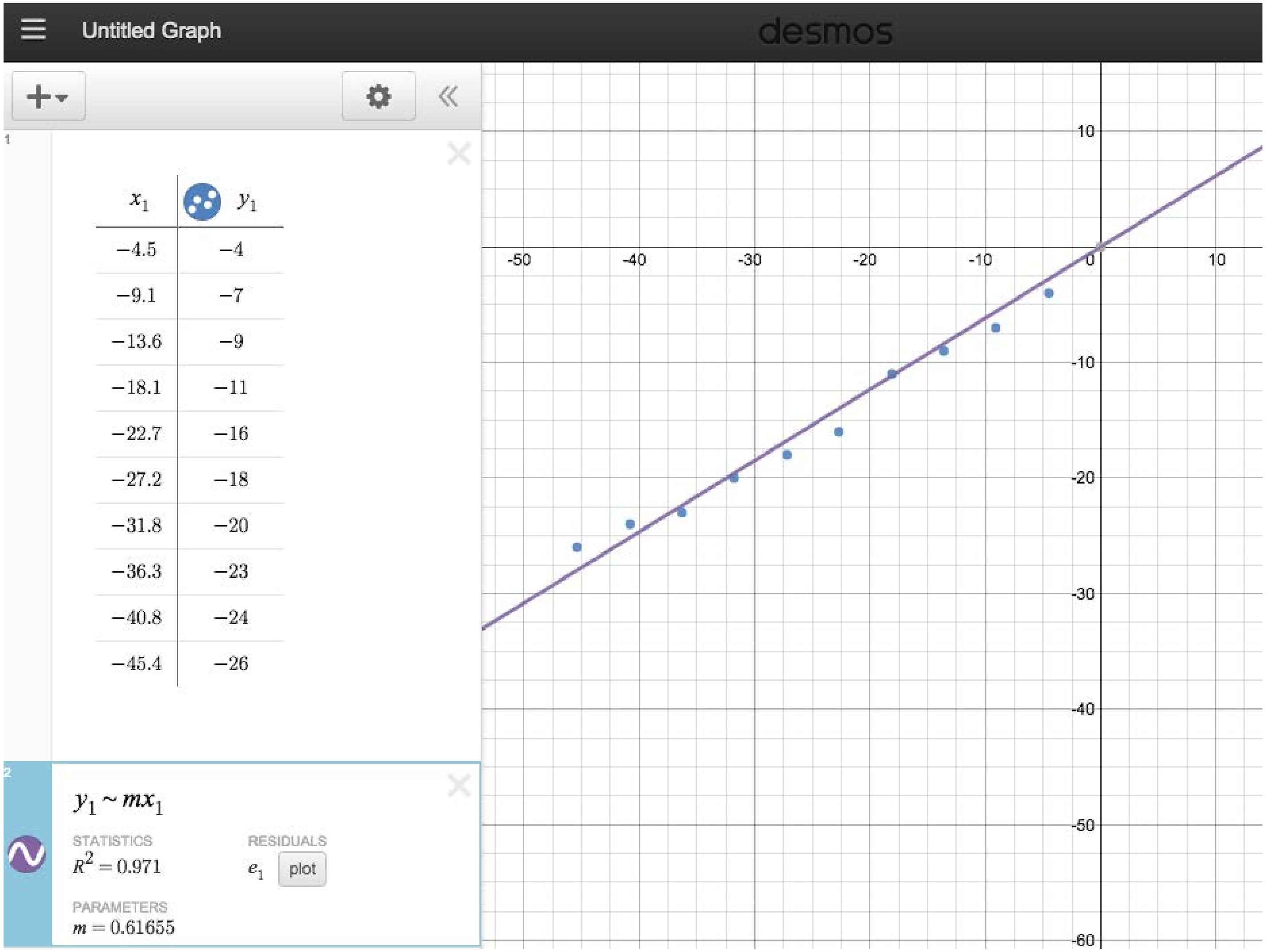
In what quadrant is the data? Why?

Then graph the data using Desmos and find the line of best fit.

After you have completed the work described above, you may continue on.

Using the video to obtain the data and Desmos to graph it, I produced a criterion table and graph of the data and forced a line of best fit through the origin; here is what I came up with:

x_1	y_1
(applied force)	(displacement)
-4.5 kg (10 lbs)	-4 mm
-9.1 kg (20 lbs)	-7 mm
-13.6 kg (30 lbs)	-9 mm
- 18.1 kg (40 lbs)	-11 mm
-22.7 kg (50 lbs)	-16 mm
-27.2 kg (60 lbs)	-18 mm
-31.8 kg (70 lbs)	-20 mm
-36.3 kg (80 lbs)	-23 mm
-40.8 kg (90 lbs)	-24 mm
-45.4 kg (100 lbs)	-26 mm



x_1	y_1
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−9.1	−7
−13.6	−9
−18.1	−11
−22.7	−16
−27.2	−18
−31.8	−20
−36.3	−23
−40.8	−24
−45.4	−26

$y_1 \sim m x_1$

STATISTICS

$R^2 = 0.971$

RESIDUALS

e_1 plot

PARAMETERS

$m = 0.61655$

How does your data table and graph compare to the above?

This is a graph of the displacement as a function of the applied force.
f(applied force) = displacement

Why did I choose to represent the independent and dependent values as negative values? In the chosen units?

In this context, what do you think these negative values mean?

What might be happening in the context of the coil shock toward the bottom of the table where values are beginning to "flattening out" in *y* column?

What do you think will eventually happen to the data in the y column if we continue collecting more data?

What would (0,0) on the graph mean in the context of the problem? Why might we want to force a line of best fit through the origin?

In this context, we were looking at a compression, which ended up being represented as a negative value. ***Compress*** might be a good, single-word description for the action that happened to the coil spring. In a different context, we might see positive values for x and y. **What might be a good word for the action that might be happening to a spring in a context where a both x and y values are positive?**

Fix your data if you agree that it should be located in the third quadrant instead of the first.

Earlier you used your own method to determine whether or not it was a function. One test that can be performed on its graph is the horizontal line test.

Another way is to look at its table of data.

Did any of the data points cause it to fail the horizontal line test?

Would they fail the horizontal line test if you kept collecting data? Explain. How might you deal with this in your model if you did continue collecting data?

Look at the Desmos graph. **Does it appear that a line of best fit ($y_1 = 0.61655x_1$) models this data and driving question appropriately?**

OK, now for the Mystery Box Challenge.

Remember that we are modeling the displacement as a function of the applied force.
f(applied force) = displacement

This means that we would need to know a mass/force to find a compression distance or displacement.

What if we knew the displacement of the compression (like the Mystery Box Challenge), and we wanted to know the force being applied to the fork? This would be a different, but related model.

It would be modeling the applied force as a function of the displacement.
f (_______________) = _______________

What is the name of this function?

How can you find the value for the mystery box?

What is another way to obtain this value?

How does plugging into the original modelling equation and solving for the inverse relate?

Why does the process of “interchanging x and y and solving for y work”? Do the variables make sense in the context of the problem? What conflicts arise? How might they be resolved?

What did you obtain for the hidden weight in the Mystery Box?

Answer: Bike Shock Reveal (video)

Why do you think the model and inverse function did not give us the exact weight that was in the mystery box?

Where might 'error' be possibly entering into our modelling process and/or model?

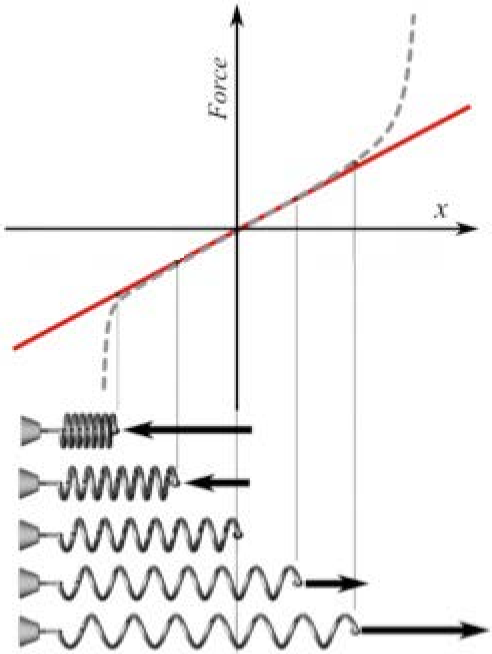
What are your conclusions about our model? How might the model be improved?

Exit Ticket: What were some of your most significant learnings from this lesson?

For reflection,
We stood outside of mathematics and looked at a driving question which has not been explicitly stated until now, ***When a coil shock suspension on a bicycle is compressed by a certain amount, is it possible to know how much force is being applied to the handlebars?***

We used the inverse function to solve this driving question and find a value. **What is the power of an inverse function?**

Below is a graph of the applied force as a function of the displacement with spring states below the graph.
f(displacement) = applied force
It's the inverse of our original model. Notice how the 'real data' are not linear as one gets to the completely compressed or elongated spring.



From Hooke's law - http://en.wikipedia.org/wiki/Hooke%27s_law