

# Speed Data Protocols

## Safety Protocols

When working with the lab materials, the following safety precautions are necessary.

- Only conduct the activity under the supervision of qualified personnel who can respond quickly to any unforeseen circumstances.
- Students involved in setting up the equipment and conducting the experiment must be properly trained in handling the sensor carts and understand the experimental procedures.
- Wear appropriate personal protective equipment (PPE) including sanitized safety glasses with side shields during the setup, experimentation, and takedown segments of the activities.
- Secure loose clothing, wear closed-toe shoes, and tie back long hair.
- Use caution when using sharps (tools, etc.), which can cut or puncture skin.
- Clear the workspace of any obstacles or hazards that could interfere with the experiment or cause accidents during the collision.
- Make sure that all parts of the carts are properly secured and stabilized before conducting the collision test. Follow manufacturer guidelines for setup and operation.
- Immediately clean up anything that falls on the floor, so it does not become a slip or fall hazard.
- Maintain a safe distance from the collision area during the activity to avoid injury from flying debris or malfunctioning equipment.
- Following the activity, inspect all equipment for any damage or wear and tear. Report any damage to the instructor so any damaged components can be repaired or replaced before further use.
- Wash hands with soap and water once all equipment is put in appropriate storage areas.

## Materials

- sanitized safety glasses with side shields
- variable speed cart (with preset braking washers and gravel/sand)
- smart cart (shared between speed groups)
- sticky tack
- painters tape
- ramp setup with brake release block
- stopwatch

- computer with access to <https://codap.concord.org/app/static/dg/en/cert/index.html> and smart cart software

## Speed Adjustment and Measurement Protocol

### Changing speed

The initial speed of the cart before the brake is applied is determined by the height on the ramp that the cart is released from. Releasing the cart from different starting points will change the speed that it is moving when the brake first engages.

If only maximum and minimum release starting points are marked on your ramp, use painters tape to mark 3 additional starting points between them.

Note: Because we only have 1 smart cart, the speed groups need to take turns. If your group does not start with the smart cart, you can begin collecting time data for each starting point while you are waiting to measure the speed value for those points. Keep track of which starting point each time measurement is for.



### Measuring speed

1: Watch one of the following videos to see how to set up the software to measure the speed of the braking cart upon reaching the bottom of the ramp:

- For Pasco carts and software (SparkVue): <https://youtu.be/4qrOLGT4K6A>
- For Vernier carts and software (Graphical Analysis): <https://youtu.be/kErZa9ZzgBA>

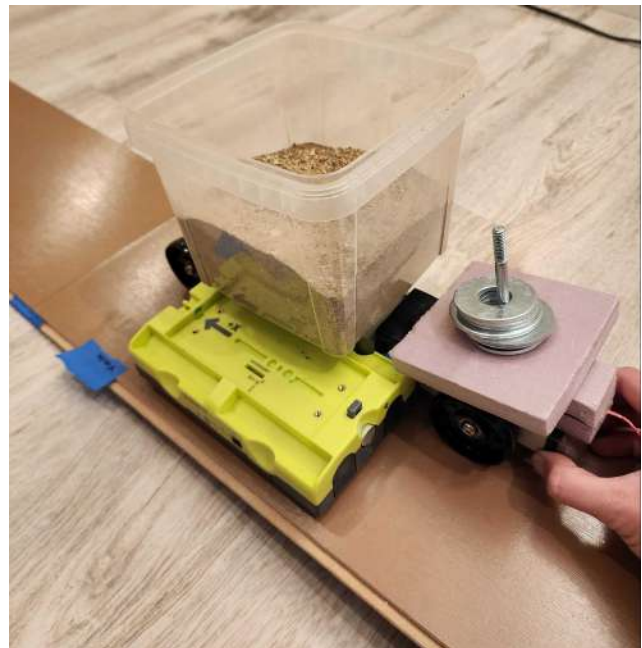
**2:** Attach the smart cart with sticky tack to the side of the braking cart, between the wheels. It should be centered on the braking cart and not interfere with the wheels or the brake.



**3:** Position the braking cart on the ramp, making sure the front of the cart is aligned with the first tape on the ramp (the lowest starting point). Be sure to align the cart so it will go straight down the ramp and not fall off, as this could damage the cart.

Place the brake trigger under the brake and place the slack of the string on the ramp behind the cart.

Note: You will not be timing the runs when the smart cart is attached.

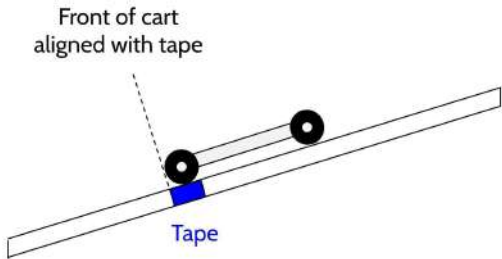
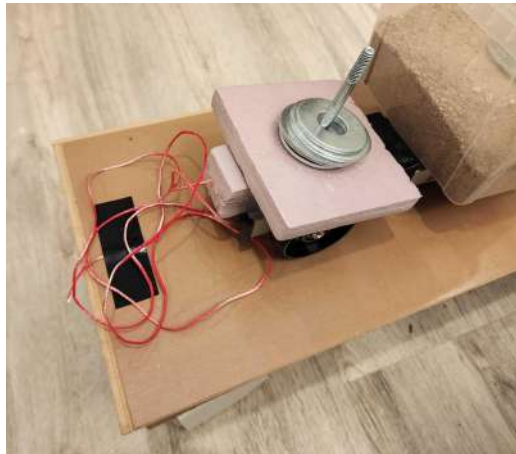


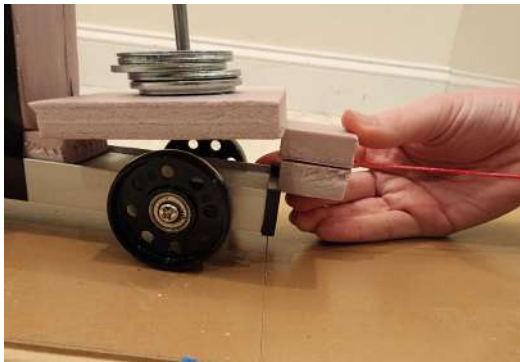
**4:** When both the person holding the cart and the person controlling the data software are ready, simultaneously start the data recording and release the cart.

**5:** Stop the data recording when the cart stops. It is OK if the cart goes off the track once it has passed the start of the flat section.

<p><b>6:</b> Read the cart's initial speed on the flat section from the graph by selecting the top of the curve, where the speed was the highest. Record this speed on your <i>Braking Investigation</i> handout.</p> <p>You may want to conduct multiple trials of all 5 starting points on the ramp and then average the speed values you collect for each starting point.</p>	
<p><b>7:</b> Repeat the process for the other 4 starting points on the ramp. Record the speed values (or the average) for each starting point on your handout.</p>	

## Cart Release Protocol

<p><b>1:</b> Position the cart on the ramp, making sure the front of the cart is aligned with the tape on the ramp that shows the starting point.</p>	
<p><b>2:</b> Place the brake trigger under the brake and place the slack of the string on the ramp behind the cart.</p> <p><b>Note:</b> The brake trigger should release the brake when the cart reaches the bottom of the ramp. If the string gets caught on anything (such as the ramp) when the cart is released, the brake will engage early and the timing data will be off. If you notice that the string got caught, redo that trial.</p>	

	
<p>3: Once the person who is timing is ready, release the cart. Watch to make sure the brake releases correctly when the cart reaches the bottom of the ramp.</p>	

## Time Measurement Protocol

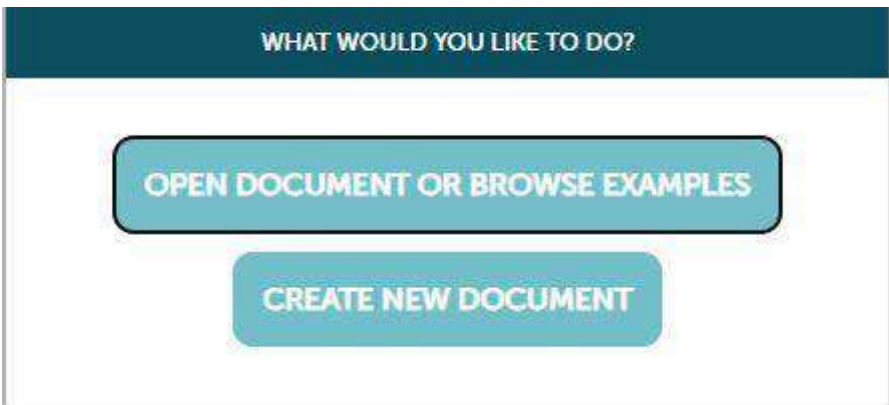
**Hand timing:** The person timing needs to let the person releasing the cart know when they are ready to time. Then have the other person release the cart. At the moment when the cart reaches the bottom of the ramp and the brake engages, start the stopwatch. Stop the stopwatch as soon as the cart comes to a full stop. To enhance accuracy, consider conducting multiple trials for each condition. Record the times on your *Braking Investigation* handout.

## CODAP Graphing Protocol

### 1: Open CODAP

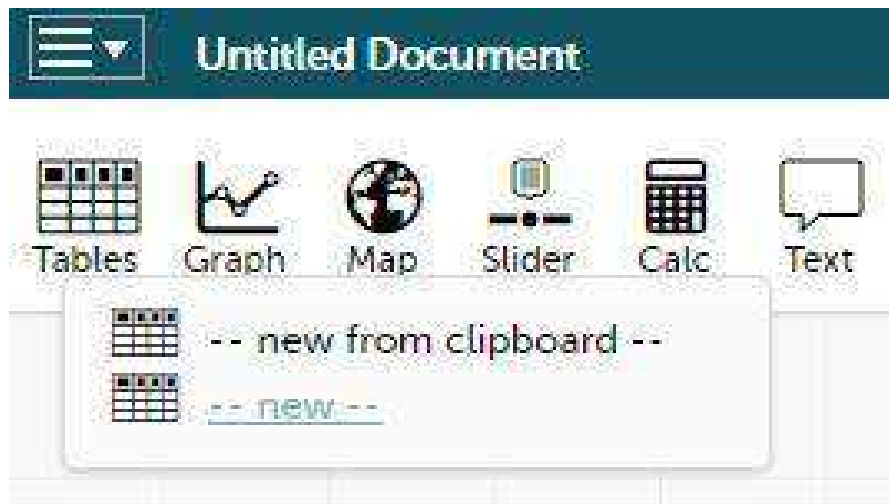
Open your web browser and type in the CODAP website's address:

<https://codap.concord.org/app/static/dg/en/cert/index.html>

<p><b>2: Create a new data document</b> Click on the "Create New Document" button.</p>	 <p>Images generated using CODAP (<a href="https://codap.concord.org/">https://codap.concord.org/</a>), developed at the Concord Consortium.</p>
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### 3: Create a table

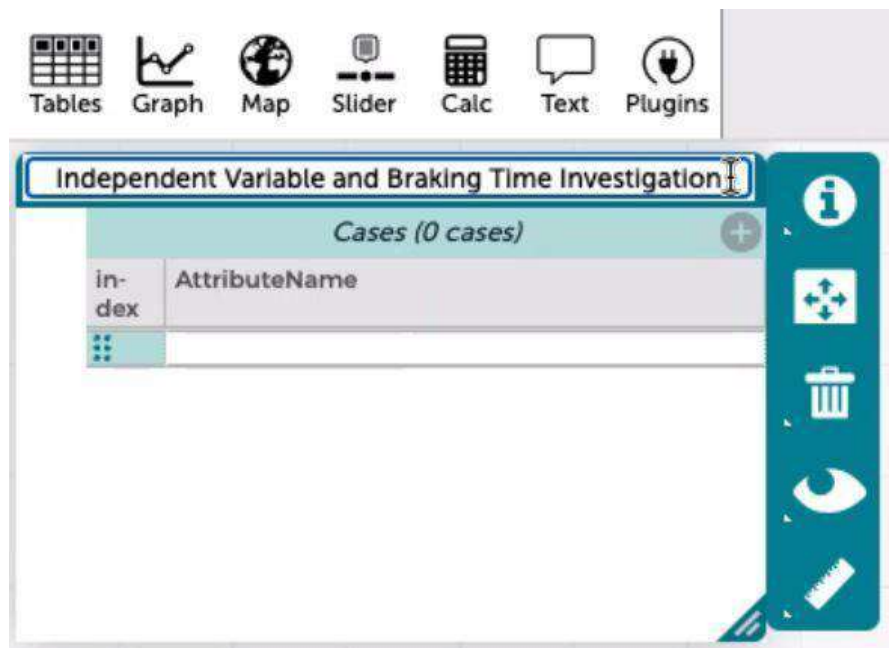
Click on the “Tables” icon in the upper left menu, then click on “--new--”.



Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

### 4: Name the table

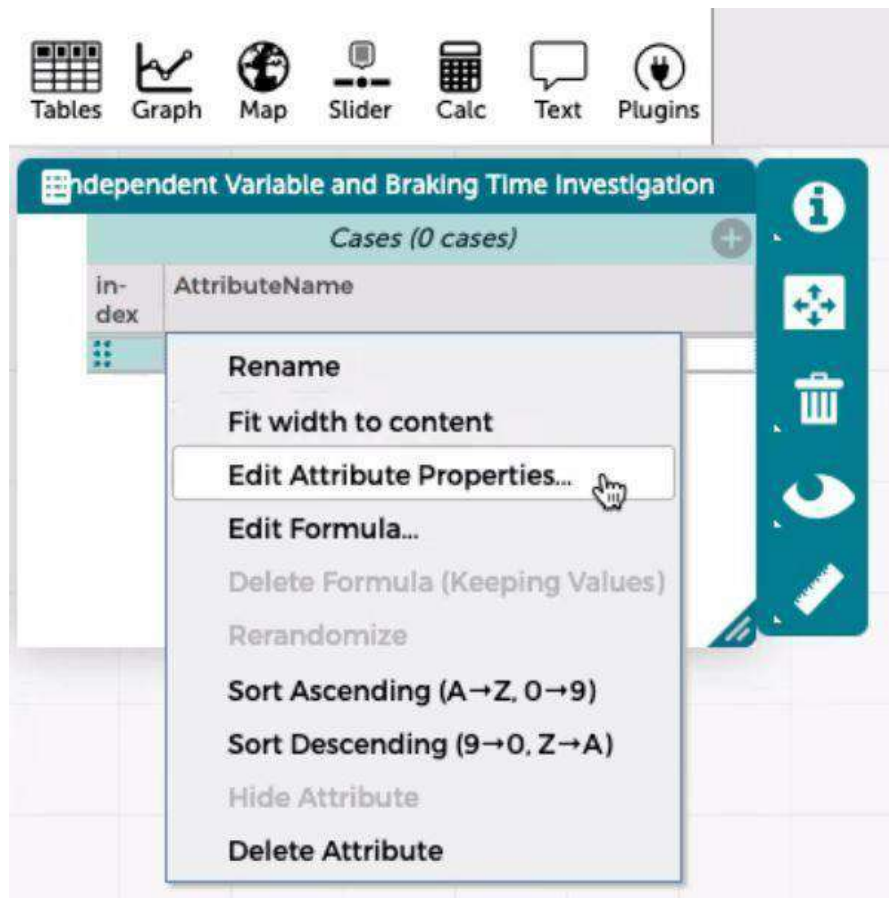
Type in a title that describes the independent and dependent variables you are investigating; for example, “\_\_\_\_\_ [your independent variable] and Braking Time Investigation”. Then press the “Enter” key. You can edit the title as needed by clicking on it.



Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

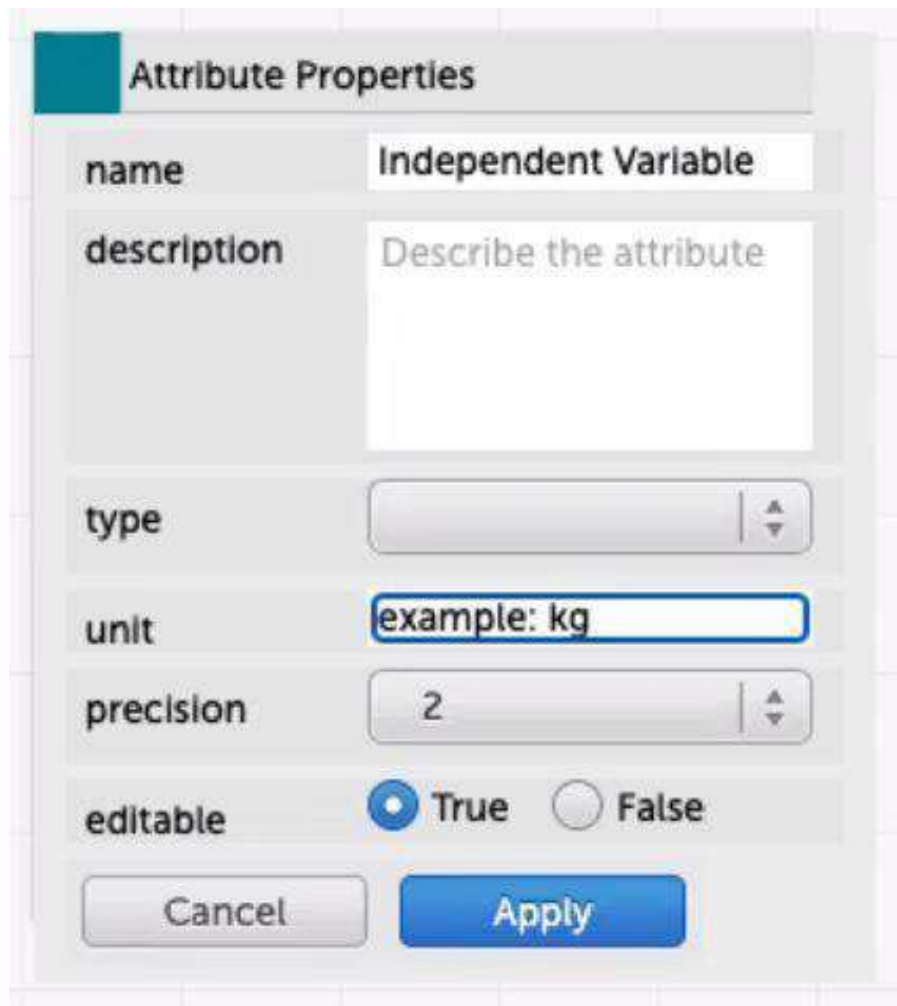
### 5: Name the independent variable column

Click on the column's heading "AttributeName". Then select "Edit Attribute Properties" in the menu. Type in an entry that represents your independent variable for "name" in the popup, and type in the appropriate "unit" below. Then click on "Apply".



Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.





The image shows a dialog box titled "Attribute Properties". It contains several input fields and controls:

- name:** A text field containing "Independent Variable".
- description:** A text area containing "Describe the attribute".
- type:** A dropdown menu, currently empty.
- unit:** A text field containing "example: kg".
- precision:** A spinner control set to the value "2".
- editable:** Two radio buttons, with "True" selected.
- Buttons:** "Cancel" and "Apply" buttons at the bottom.

Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

**6: Add and name a dependent variable column**  
Click on the gray plus sign ⊕ in the upper right part of the table. As in **step 5**, type in a name for the dependent variable and the unit, then click on "Apply".



The image shows the CODAP interface. At the top is a toolbar with icons for Tables, Graph, Map, Slider, Calc, Text, and Plugins. Below the toolbar is a window titled "Independent Variable and Braking Time Investigation". Inside the window is a table with the following structure:

Cases (0 cases)	
in- dex	Independent Variable (example: kg)

A context menu is open over the table, showing a plus sign icon at the top right. A tooltip next to it says "Add a new attribute to this table". The menu also contains icons for information, delete, and other actions.

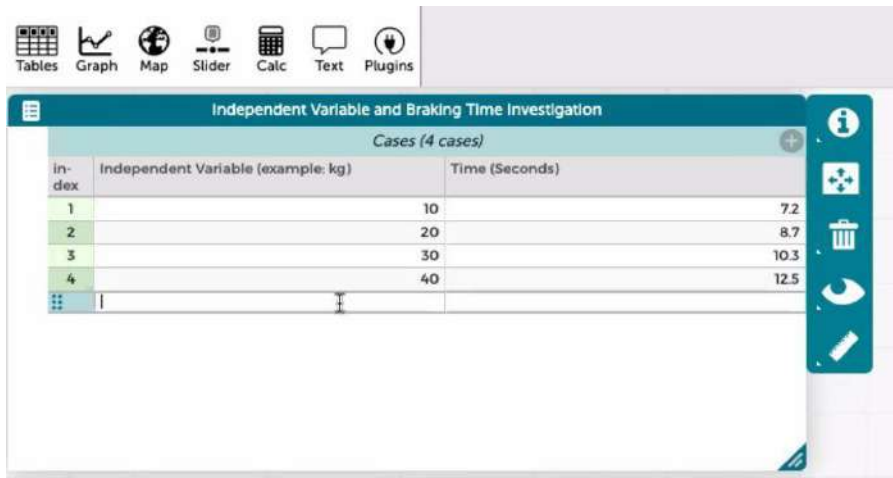
Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.



## 7: Input your data

To add data to your table, double-click on the appropriate cell and type in the value you recorded. Then press the “Enter” key.

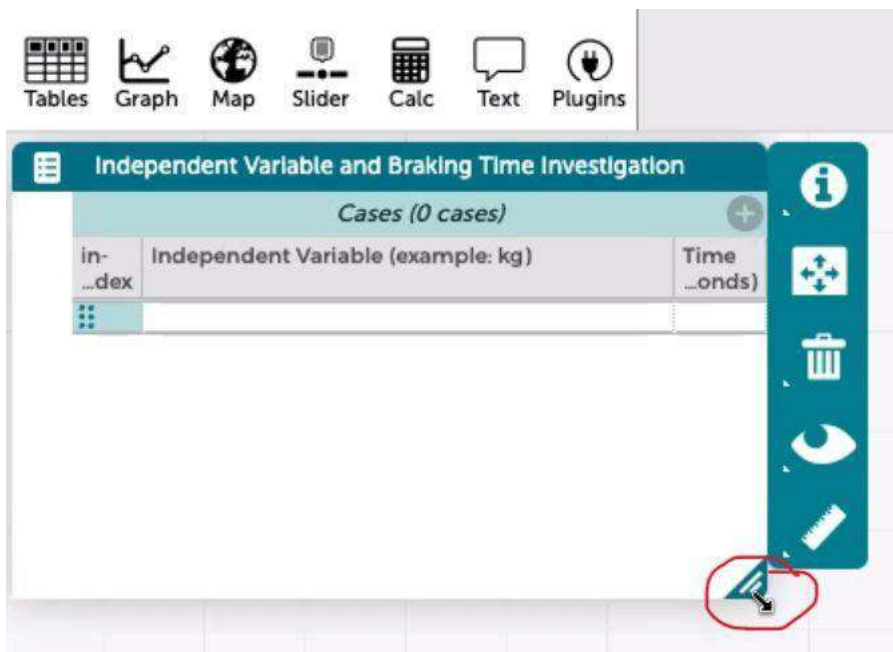
You can resize the table by clicking and dragging its bottom right corner.



The screenshot shows the CODAP interface with a table titled "Independent Variable and Braking Time Investigation". The table has 4 cases. The columns are "in-index", "Independent Variable (example: kg)", and "Time (Seconds)". The data is as follows:

in-index	Independent Variable (example: kg)	Time (Seconds)
1	10	7.2
2	20	8.7
3	30	10.3
4	40	12.5

Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.



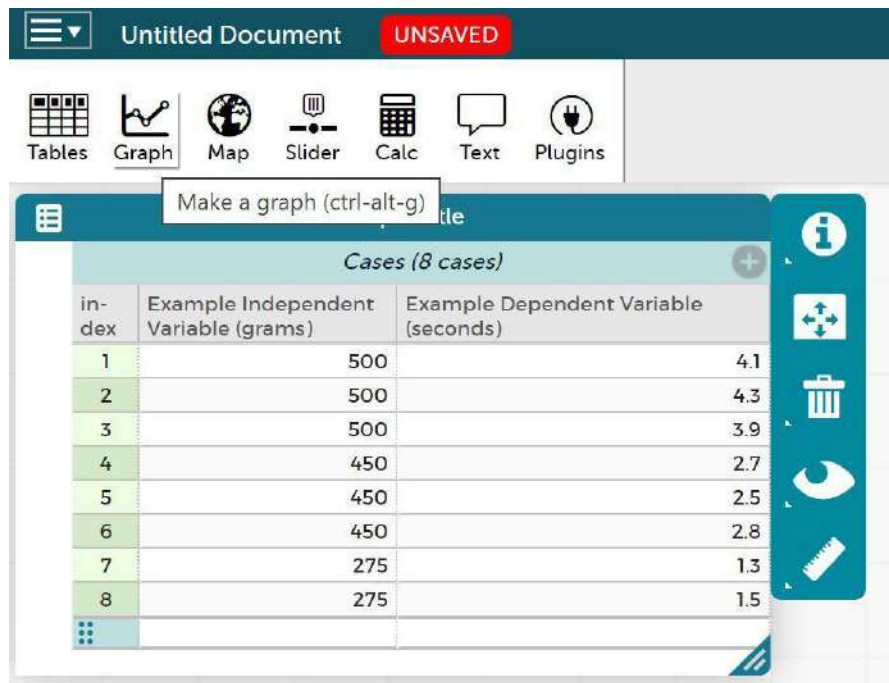
The screenshot shows the CODAP interface with an empty table titled "Independent Variable and Braking Time Investigation". The table has 0 cases. The columns are "in-index", "Independent Variable (example: kg)", and "Time (Seconds)". A red circle highlights the bottom right corner of the table, indicating the resize handle.

in-index	Independent Variable (example: kg)	Time (Seconds)
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Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

### 8: Create a blank graph

Click on the “Graph” icon in the upper left menu. This will open a graph window with random data points.

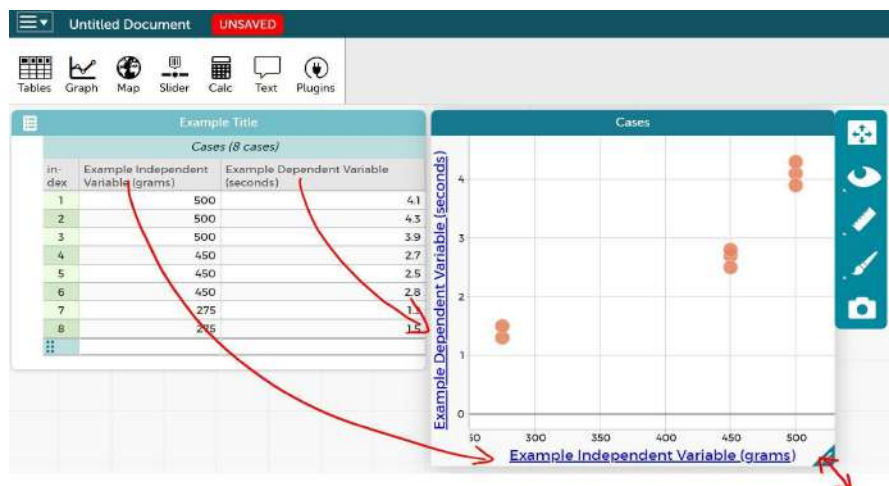


Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

### 9: Assign variables to the graph axes

Click and drag the heading of your independent variable column to the x-axis of the graph. Then click and drag the heading of your dependent variable column to the y-axis.

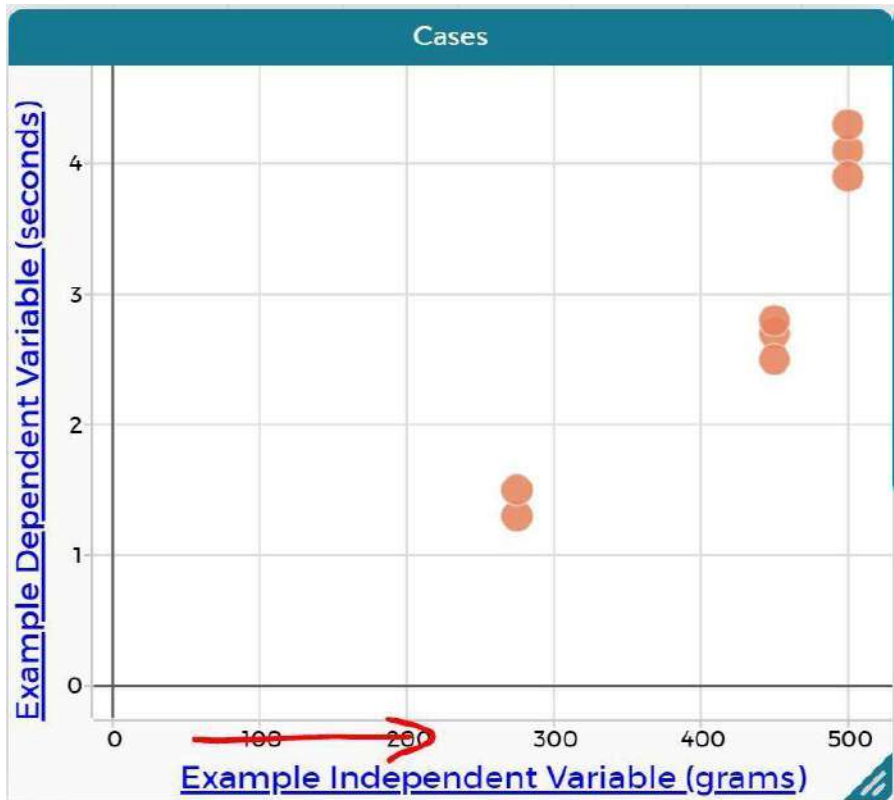
You can resize the graph by clicking and dragging its bottom right corner.



Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.

### 10: Adjust the scales of the graph axes

Click and drag the axes of the graph to adjust the scales to show zero on both.



Images generated using CODAP (<https://codap.concord.org/>), developed at the Concord Consortium.