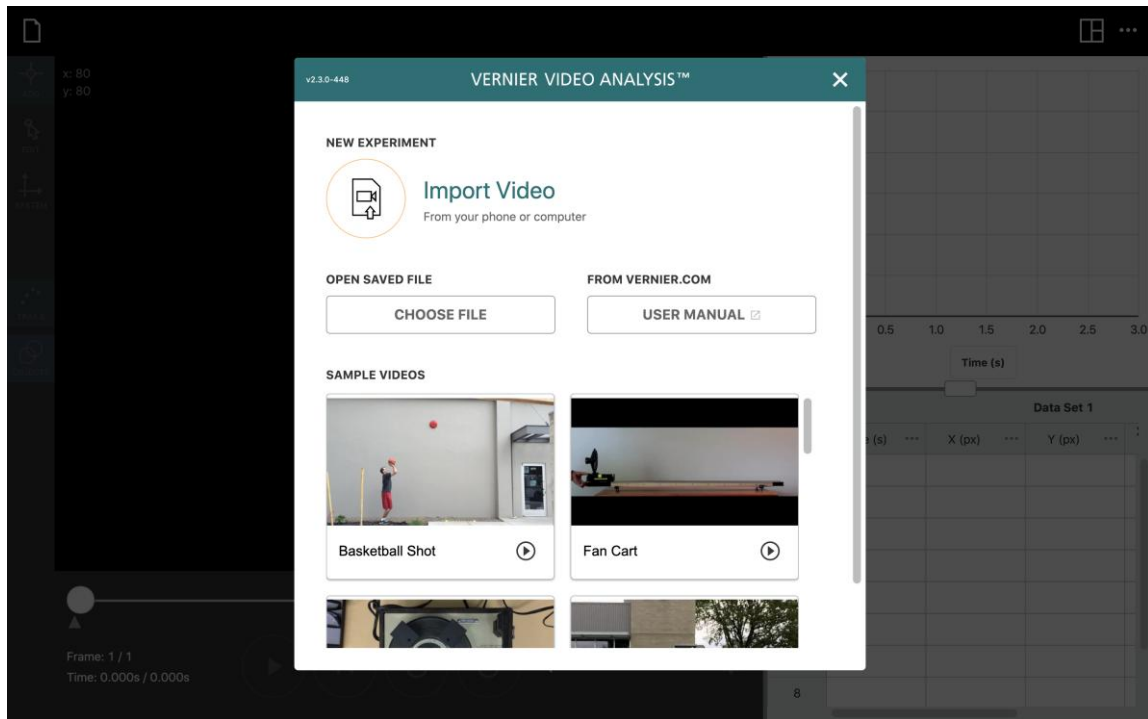


# Vernier Video Analysis™ – User Manual



Version 2.4  
December 2020

## ABOUT THIS GUIDE

Vernier Video Analysis™ is a tool for science students to analyze the motion of real-world objects in videos. Students use dots to mark the position of objects in successive frames of video. When a scale and axes are defined, the app assigns each point spatial coordinates and uses these and the time (based on frame number) to calculate vertical and horizontal velocities. This document reflects features available in Vernier Video Analysis version 2.4.

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## I. GETTING STARTED WITH VERNIER VIDEO ANALYSIS

### Compatible Browsers and Platforms

The Vernier Video Analysis app runs in a browser. As a sophisticated application using many advanced calls in a browser, Video Analysis requires a nearly current version of compatible browsers.

Video Analysis is designed to run in Chrome™ 81 or newer, Firefox 75 or newer, and Safari® 13 or newer browsers. Compatible browsers can run on Chrome OS 81 or newer, macOS®, Windows® 10, iPadOS® 13 or newer, iOS 13 or newer, and Android™ 6 or newer.

Because Vernier Video Analysis is updated frequently, and updates are automatically distributed to users, Video Analysis requires that the browser be in the current version or one version older only. It is unusual to have to manually update browsers; unless actively blocked, they update themselves to the current version as a matter of maintaining security patches. You can determine current browser versions at <https://www.whatismybrowser.com/guides/the-latest-version>

### Activating Video Analysis

After requesting your free trial and/or after purchasing a license, you will receive an email from [info@vernier.com](mailto:info@vernier.com) with your access link.

Click the link in the email or browse to the URL provided. You should immediately see the welcome screen as shown in [Step 1](#)

The primary URL for access once activated is [videoanalysis.app](#)

**Note:** It is useful to bookmark this URL for easy access.

If you navigate there directly without using the supplied authentication URL, you will see an activation screen. In that case, enter the license key provided.

Activation information for Video Analysis is stored in browser files (cookies). If the browser files are cleared, or if a different browser is used, the activation screen will be displayed.

### Site License Terms

A purchased site license lasts through the end of June 30<sup>th</sup> of the year following the year of purchase. During the site license duration, you are free to distribute your keyed link to all faculty, staff, and students of your school campus. In the case of your school having multiple campuses, a separate purchased license key is required for each campus.

### Privacy Statement

#### COPPA, SOPIPA, and FERPA Compliance

Vernier Video Analysis complies with federal regulations pertaining to student privacy and safety in the following ways:

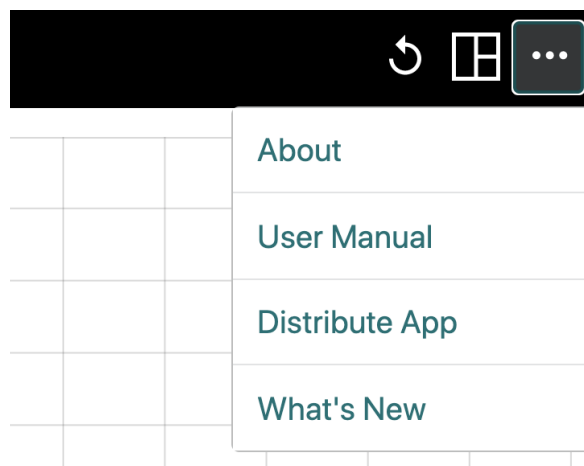
- Vernier Video Analysis does not collect, request, share, or store any personal information from students or instructors.
- Vernier Video Analysis does not display advertisements in the app.

## Distributing Video Analysis to Colleagues and Students

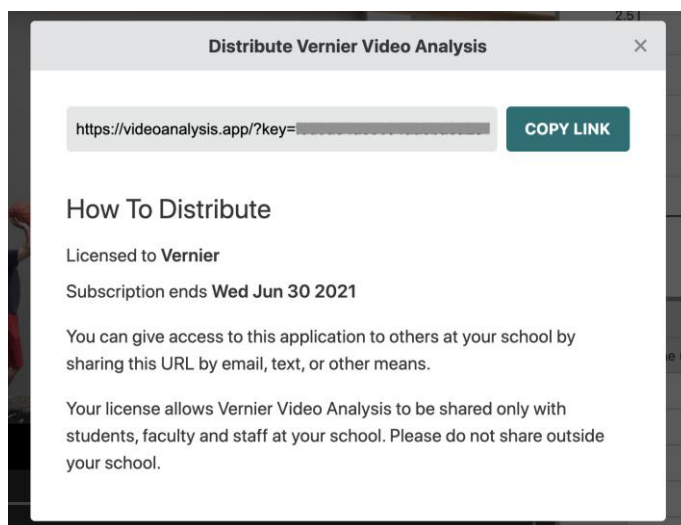
Click the link in the email or browse to the URL provided to open Vernier Video Analysis. Or, if you have previously opened Vernier Video Analysis, go to [videoanalysis.app](https://videoanalysis.app)

You should immediately see the welcome screen as shown in [Step 1](#)

In order for your colleagues and students to access your licensed software, they need a link tied to your license key. To access this link, click or tap the Other Options menu (three dots in the upper right corner of the screen). You will see a drop-down menu that includes the option to Distribute App. Click or tap Distribute App.



A box will appear with your license key link and license expiration date. Click or tap the Copy Link button to insert the link onto your device's clipboard. Paste the link into an email, or add it to a password-protected site such as your school's learning management system (LMS).

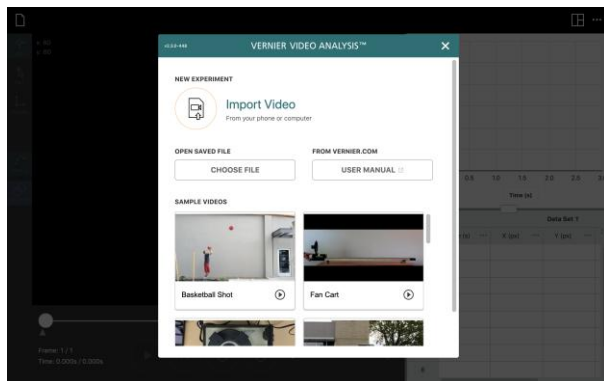


## II. ANALYZING A VIDEO IN VIDEO ANALYSIS

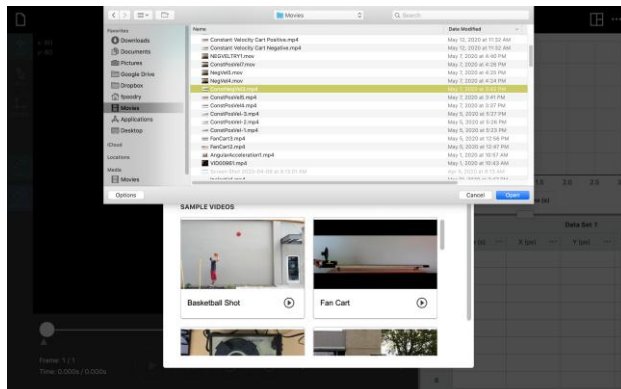
Follow these steps to quickly get started with analyzing a video. These steps assume you already have Vernier Video Analysis open in a browser window, at [videoanalysis.app](http://videoanalysis.app).

### Step 1: Import a video into Video Analysis



1. Click or tap Import Video, or choose one of the Sample Videos. Scroll to see additional Sample Videos. Click or tap Choose File, , to open saved Vernier Video Analysis files (.vmbf).



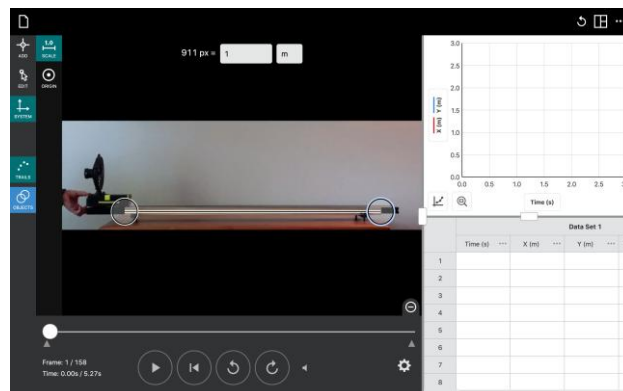
2. If you choose Import Video, select a video and click or tap Open. **Note:** The file selection dialog will look slightly different depending on your device.



## Step 2: Set the scale and the origin


Click or tap on the System icon,  SYSTEM, on the left side of the app. Select Scale,  SCALE.

1. Move the centers of the scale circles to the ends of your scale object.

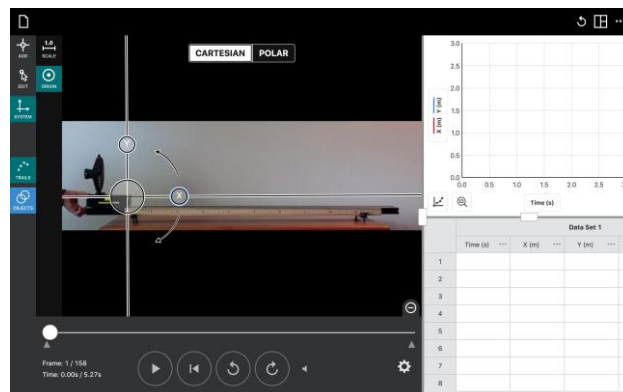


2. Type in the value and units of your scale object.




3. Select Origin,  ORIGIN. Move the origin to where you want it. The horizontal direction is X and the vertical direction is Y.

Adjust the rotation of the axes, if desired. For example, you may want to orient the x-axis so that it aligns with a ramp. Click or tap on the X or Y and drag the axes to align as you like.



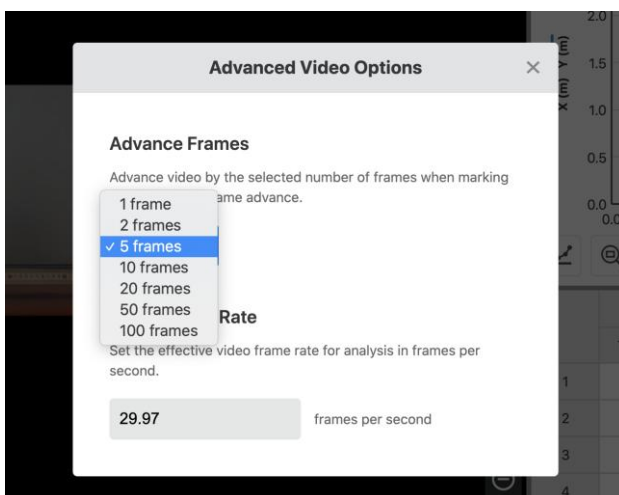
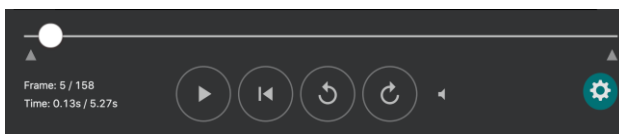
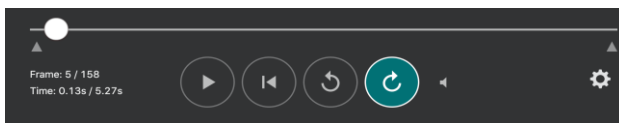
For information about using polar coordinates, see the Analysis Tools section

## Step 3: Mark points


Click or tap on the crosshairs icon,  ADD, to add points for motion analysis.

1. Click or tap forward in the video to the frame you want to begin with. This is typically the frame when motion begins or right before motion begins. If desired, you can trim the beginning and end of the video clip to include only the motion of interest. See the Additional Video Features section for details.

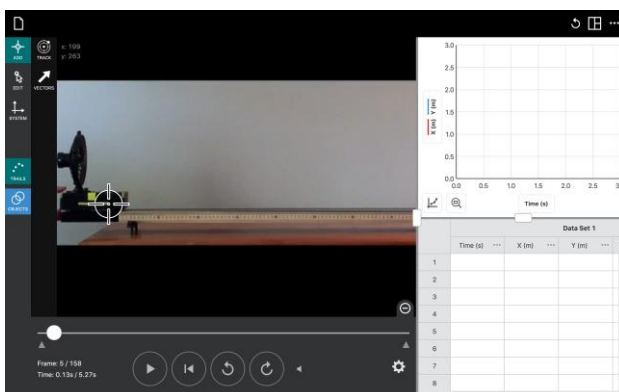
If you would like to change the frame increment for advancing through the video, click or tap the gear icon (Advanced Video Options) to select advancing the video by multiple frames.



2. Move the crosshairs to the point on the object that you want to track.

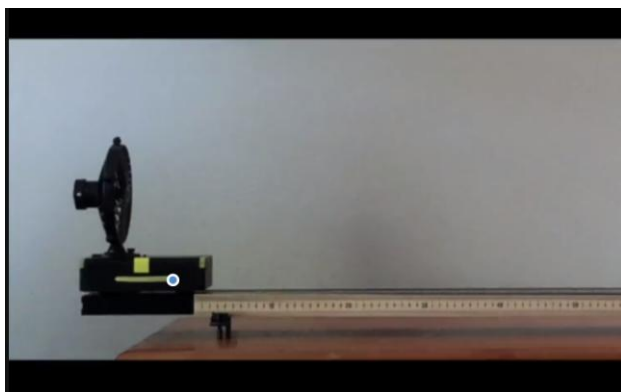
**TIP!** Enlarge the video window for more precision in marking points. Use the view menu, , to remove the graph and data table. To further enlarge the view, zoom in using pinch gestures on a multitouch device (such as a smartphone, tablet, touchscreen computer, or Chromebook) or use a track pad.

Pan across the video by dragging with two fingers, or hold the Shift key down, then click and drag across the video.






- When you click or tap to mark a point, the coordinates of the point will be recorded in the data table, a point will be added to the graph, and the video will advance one frame (or however many frames you have selected).

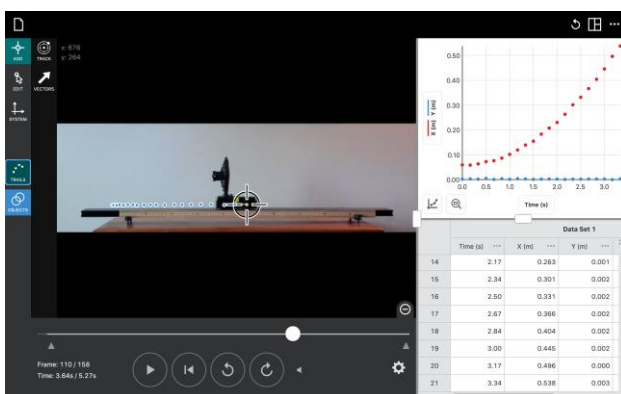


- Continue to click or tap on your moving object to mark points until you reach the end of a video or the end of the portion of the motion you are analyzing.

**TIP!** If the visible points are in the way of placing subsequent points accurately, disable Trails by clicking or tapping on the Trails icon: 

TRAILS

You can also advance the video without marking a point, or change the number of frames to advance with each point, even if you have already started marking points.



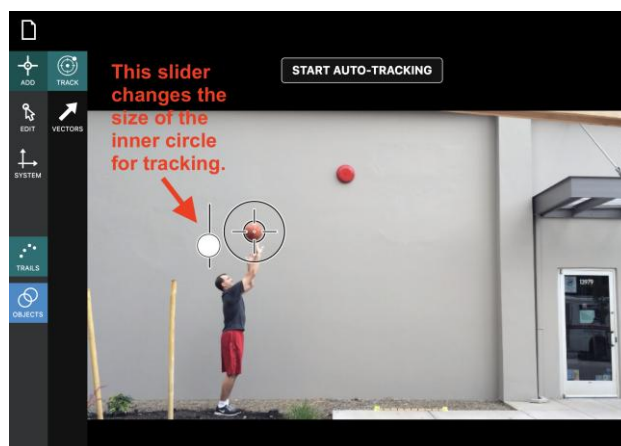
## Optional: Autotracking

Vernier Video Analysis is able to automatically locate an object in frames and mark its location with a point. This feature can speed analysis of longer videos and remove the tedium of marking many frames. An algorithm is used to identify the object against the background in the video. If the algorithm is unable to identify the object against the background, autotracking stops.

If you plan to use automatic tracking, the plainer the background the better. A blank white or gray wall is best, as even cinder block edges can be confusing to the software. It is also helpful if the color of the object you are tracking contrasts well with the background. For example, use a brightly colored ball or place a bright sticker on a dark object.

Center the autotracking cursor on the object to be tracked, and adjust the size of the inner circle to be slightly larger than the object. Click or tap Start Autotracking to begin.


If the object is lost, tracking stops; to continue, reposition the cursor on the object and restart autotracking.



If tracking is unreliable, try making the inner circle slightly smaller or larger using the slider. Note that if your object is larger than the outer circle, tracking may be impossible, but you can try tracking the leading or trailing edge of the object. For large objects, placing a bright sticker on the object can help.

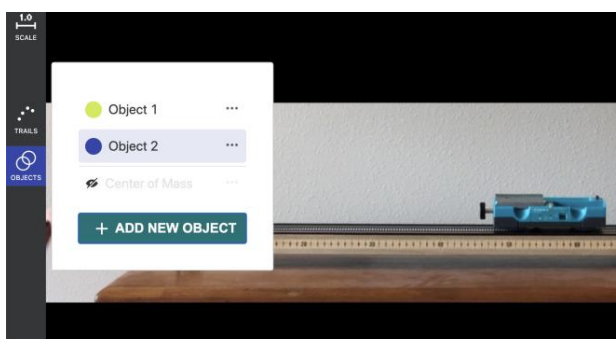
Sometimes autotracking needs a little help through complex motions or backgrounds. For these instances, you can perform a mixture of autotracking and manual tracking. To mark points manually while in autotracking mode, drag the autotracking cursor to the location you want to mark, release, and then tap or click to leave a manual point.

### **Optional: Add points for an additional object**

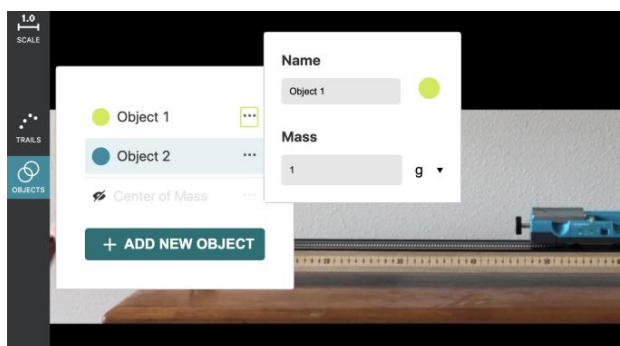
Click or tap on the objects icon,  OBJECTS, to add points for additional objects. Tracking multiple objects is useful to study collisions and other interactions. Center of mass calculations are available when two or more objects have been tracked.

1. When you click or tap on the Add New Object button, an additional object will be added with a different dot color indicated. Change the dot color by clicking on it and choosing a new color.

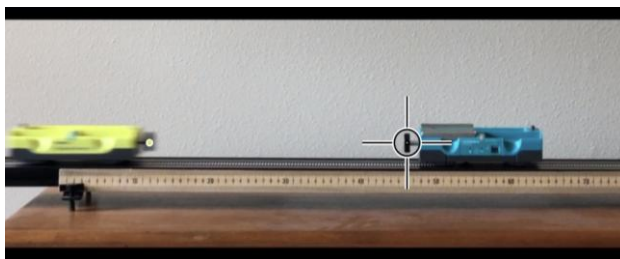
You can return to any point series for marking by selecting it from the list.



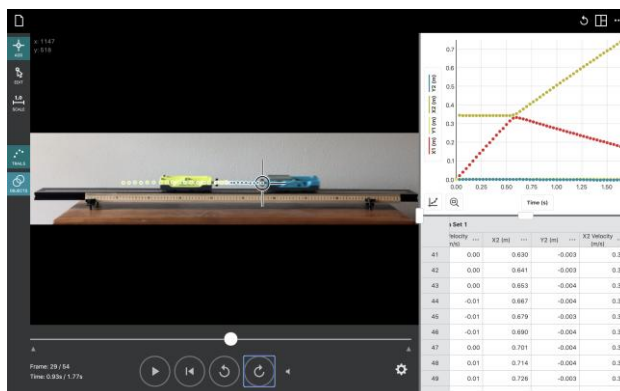
- Use the three dots menu to the right of each object to change the name and the mass of the object.



- Starting with the first video frame of data collection for the first object, click or tap on your second object to collect data for its motion.

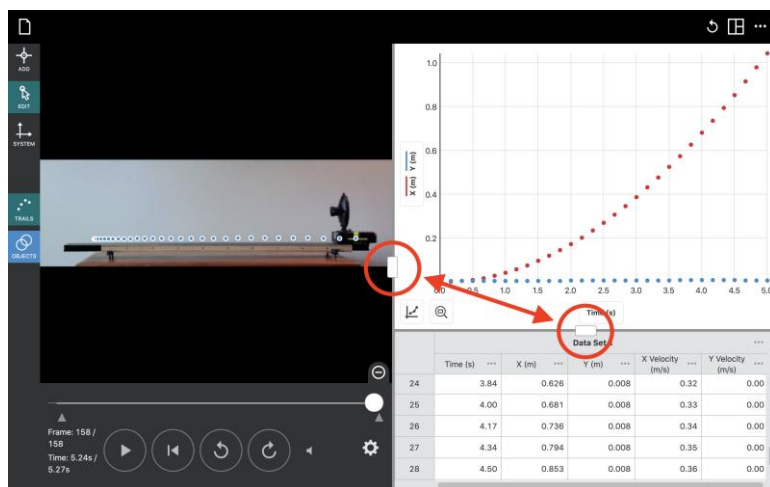


- Continue marking the location of the second object in the same frames in which you marked the first object.

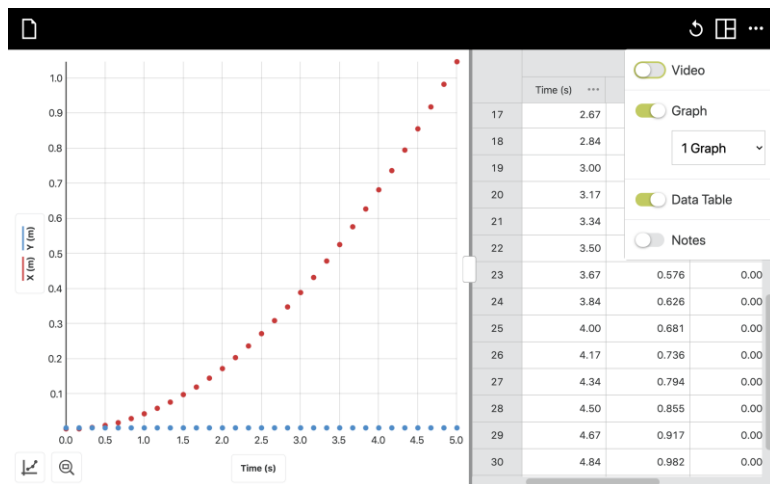


## Step 4: Analyze the graphs


1. If you want to make the graph larger, click or tap and drag the handles to change the borders of the video, graph, and data table in the Video Analysis window.

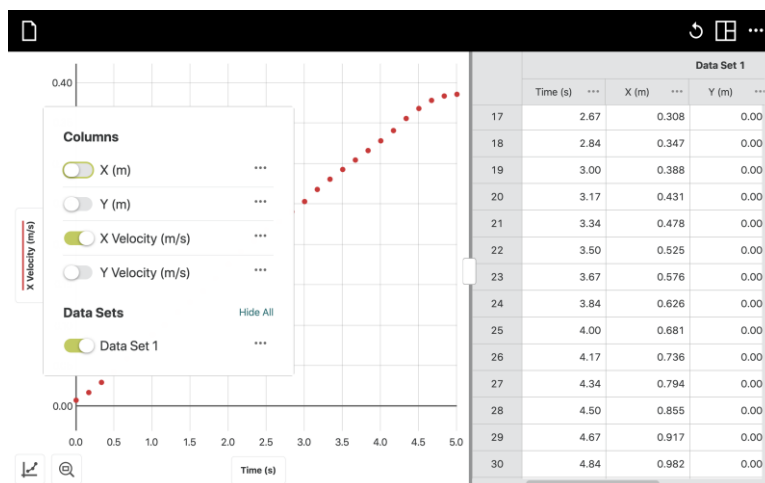


2. Change which elements are visible using the View menu in the upper right corner of the window:



- To change which data are graphed, click or tap on the vertical axis label.

Click or tap  to autoscale the graph to fit the data. You can also double-click or double-tap the graph to autoscale the graph to fit the data

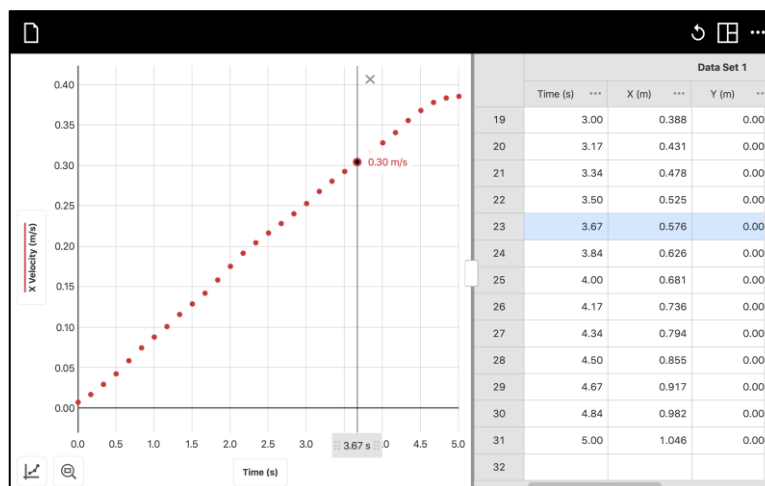


- Click or tap the graph to examine a point of interest. The coordinates of the point are shown.

Click or tap a different point or drag the examine line to further examine your data.

To remove the examine line, click or tap the close button, ×, displayed next to the line.

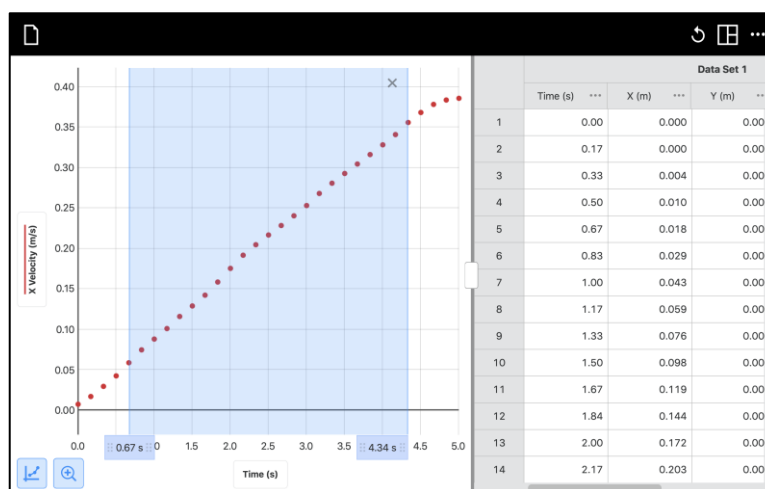
When viewing multiple graphs, the examine line shows on all graphs.




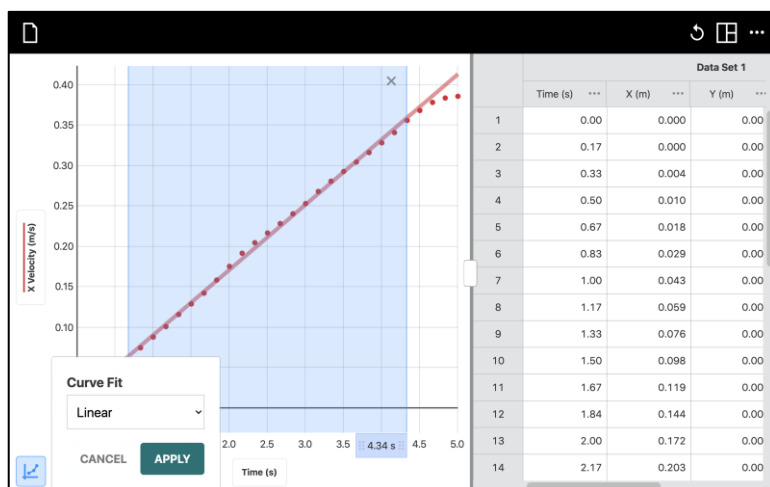
- Click-and-drag or touch-and-drag across the graph to select a region of data for analysis. The selected region becomes highlighted.


- To modify a region, drag the edges of the region.
- To remove a selection, click or tap the close button, ×, displayed on the region.


**TIP!** To analyze all data, you do not need to select a region.



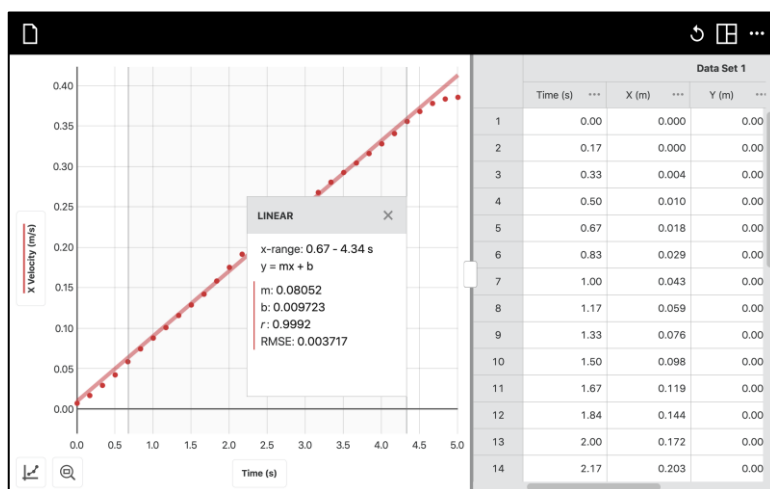
- To fit a curve to the data, choose Apply Curve Fit from the Graph Tools menu, , then select the desired fit equation. A preview of the curve fit is displayed on the graph.



- Click or tap  to display the curve fit equation and coefficients on the graph.

To remove the curve fit, click or tap the close button, , on the details box.

**TIP!** If the curve fit box covers part of your data, mouse over the gray area at the top of the box. An up and down arrow appears, and you can drag the box vertically to avoid obscuring data.

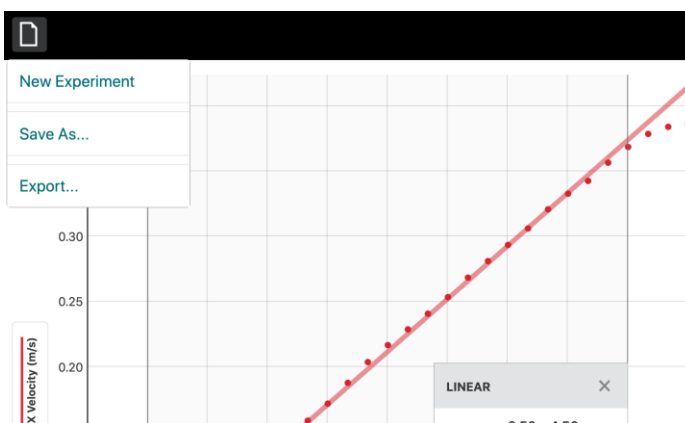


## Step 5: Save your work

You can save your file to a local file or to a cloud-based location. Most browsers will prompt for a file name and location. Depending on the settings in your browser, you may not be prompted to the saved location and file name; if this is the case, look in the downloads folder you have configured for your browser.<sup>1</sup>

<sup>1</sup> To change this setting in Chrome™, go to Settings>Advanced>Downloads and enable “Ask where to save each file before downloading.” You will need to quit Chrome and restart it for the change to take effect.

Saved files include the inserted video.

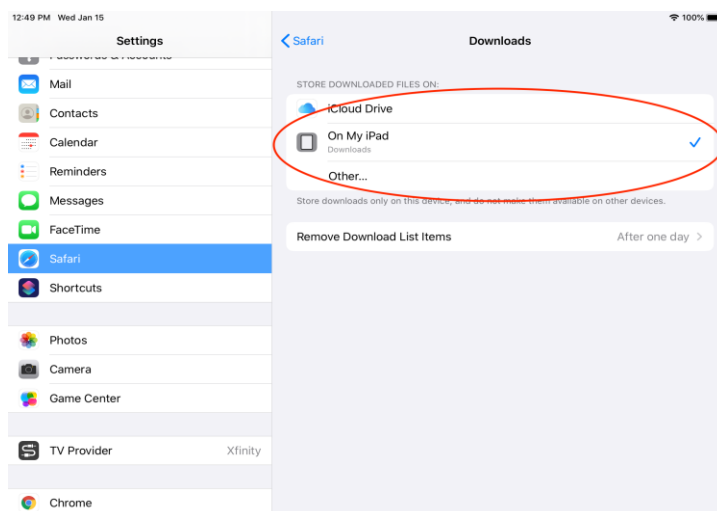
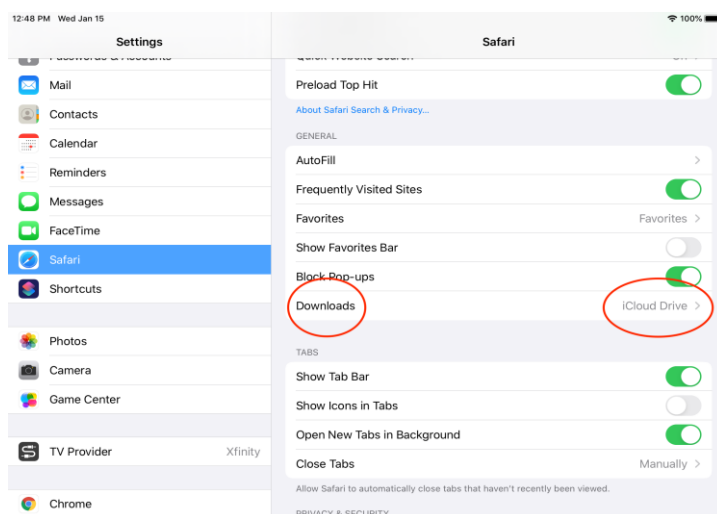


Note (when using Safari for iOS and iPadOS users): Choosing Save As... saves the file to your device's Downloads folder.

This folder is either on iCloud or on your device, depending on your device settings.

You can change the location in Settings by choosing Safari and changing the Downloads location setting.

Once your file is saved to your Downloads folder, you can move it to any location, including Google Drive™ or other cloud locations that are available on your device.



## Step 6: Edit your work



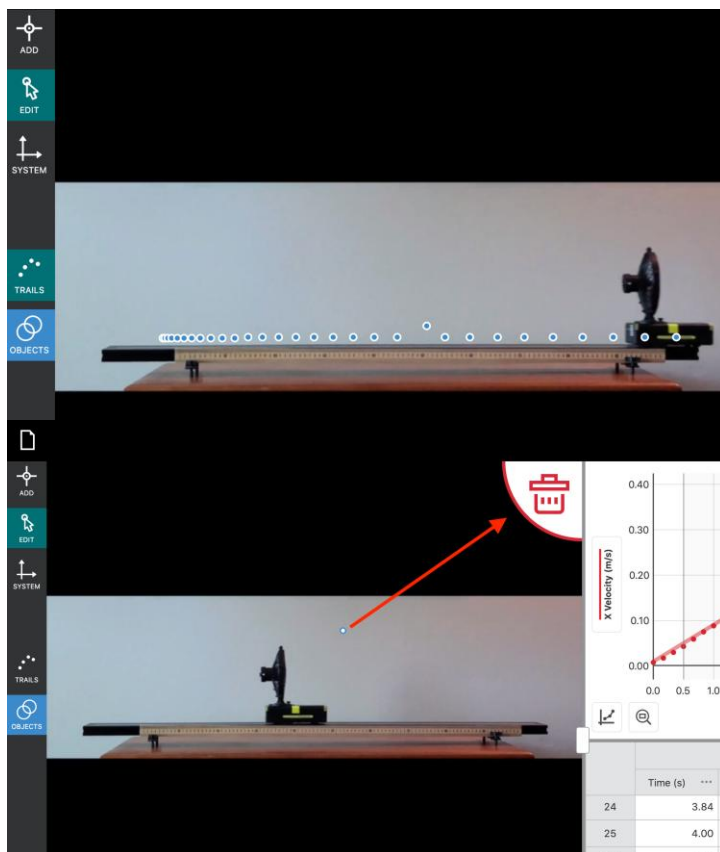
If you want to move or delete a marked point, first enable Editing with the Edit button, **EDIT**.

Then you can select and drag any point. It is easier to reposition a marked point if you turn off Trails and return to the frame corresponding to the point. This way a single point is displayed.

There are two options to delete a point. In both cases, select the point first. It will change color to white.

Method 1 is to drag the point up to the upper right where a trash can icon will appear. Continue dragging the point into this area and then drop it to delete the point.

Method 2 can be used if you are using a device with an external keyboard. For this method simply press your keyboard delete button once the point is selected.



To update scale or origin location, click the Scale button to display the tools. Reposition them as needed.

Saving is not automatic, so you will need to re-save the file if you want your changes to be permanent.

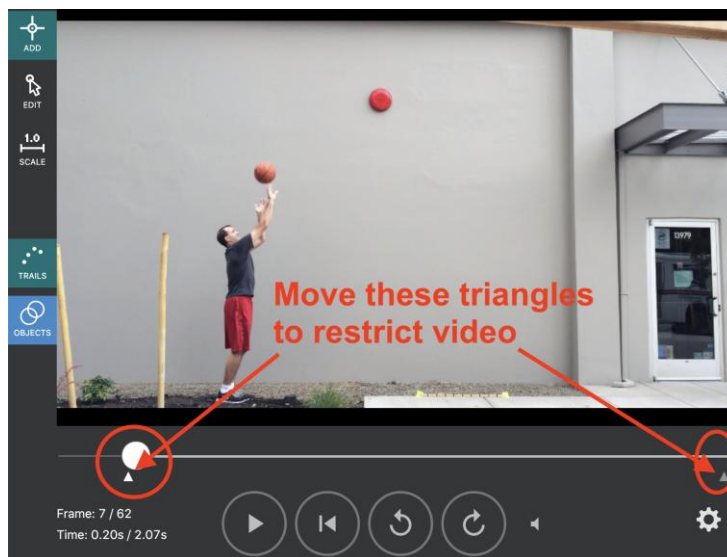


### III. ADDITIONAL VIDEO FEATURES

#### Trimming Video

If there are multiple frames of video before and/or after the motion to be analyzed in Video Analysis, the video playback can be restricted to only the frames containing the motion to be analyzed. Move the small triangles at either end of the video scrubbing bar until only the relevant portion of the video plays.

This is especially useful if you are tracking multiple objects and need to return to exactly the same starting frame each time.



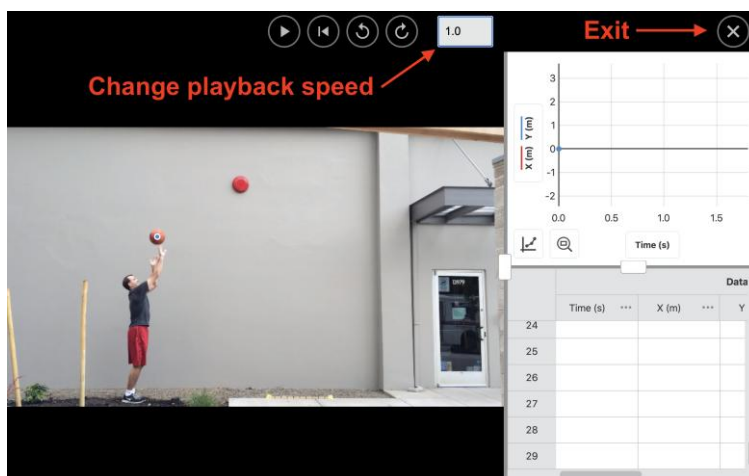
#### Replay

The replay feature is for use after all the data points have been added. You can use it to replay the video as data points are added to the graph and table. The playback is synchronized with all three elements: data table, graph, and video with added points.

Adjust the playback speed using the menu at the top of the playback view.

**TIP!** Slow down the replay to entering a fractional value, such as 0.25 or 0.667.

Exit the playback view using the X button in the top right corner.



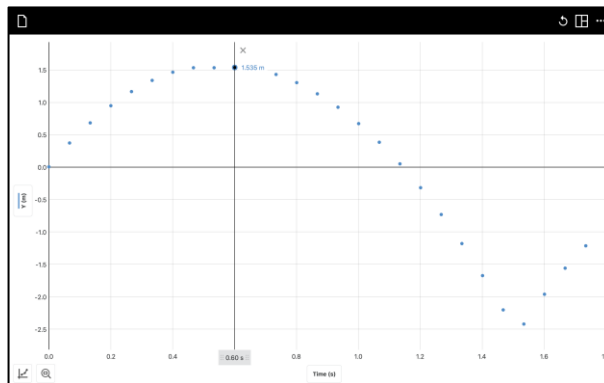
## IV. ANALYSIS TOOLS

### Examining Data Points

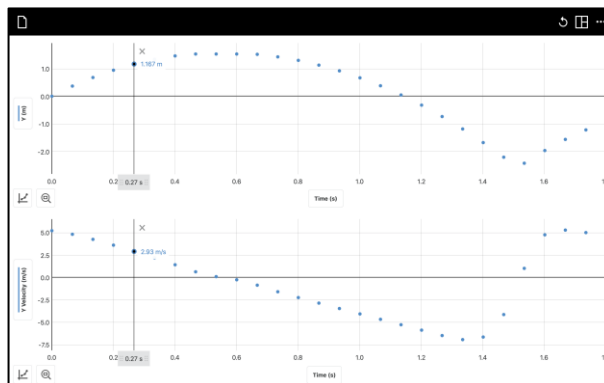
Click or tap the graph to examine a point of interest. The coordinates of the point are shown.

Click or tap a different point or drag the examine line to further examine your data.


To remove the examine line, click or tap the close button,  $\times$ , displayed next to the line.



When viewing multiple graphs, the examine line displays on all graphs referencing the same independent variable.

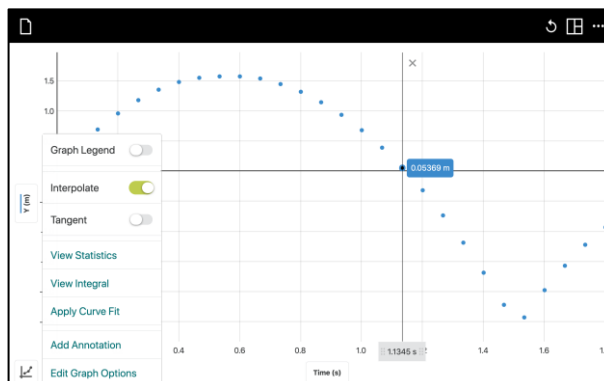


### Interpolating and Extrapolating Data

To examine values between and beyond your data points, click or tap  and select Interpolate.

The interpolate function affects the behavior of the examine cursor when examining data.

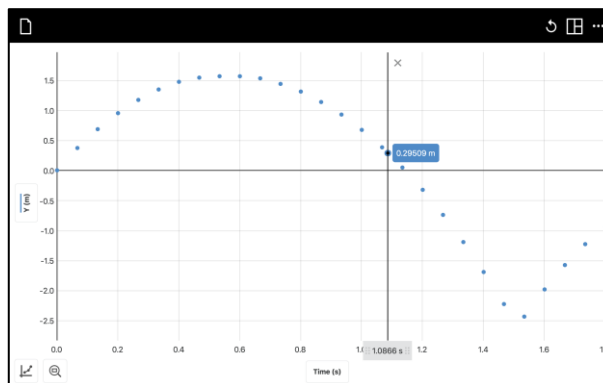
While interpolate is off, the displayed examine values are for plotted data points. As you move the examine line, the value of the nearest data point is displayed.



While interpolate is on, you can estimate values between plotted data points. The values displayed depend on whether or not you have a curve fit plotted on the graph.

### Interpolate Without a Curve Fit

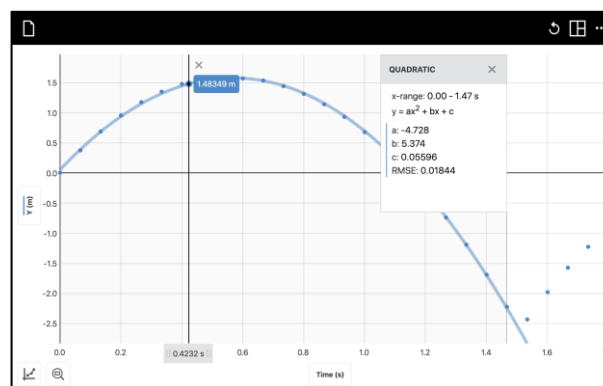
When there is no curve fit, the examine cursor follows the straight-line path between two consecutive points.




### Interpolate with a Curve Fit

When there is a curve fit, examine follows the curve fit model to determine the examine values.

To examine data points beyond your data (extrapolate), you must have a curve fit plotted on the graph and interpolate turned on.

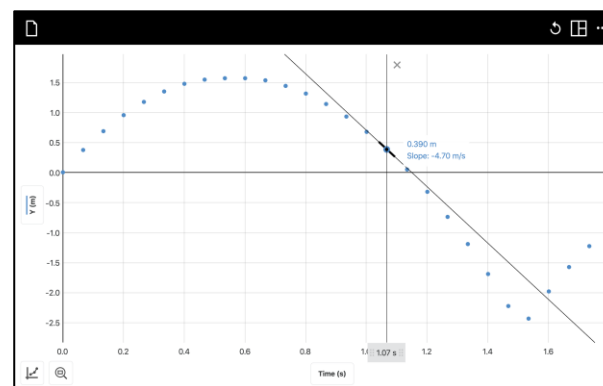


### Exploring Rate of Change (Tangent)

To find the rate of change of your data at any point, click or tap  and select Tangent.

The tangent tool calculates the rate of change of the data (slope) at the examined point. The tangent value is determined based on the points immediately around the examined point.

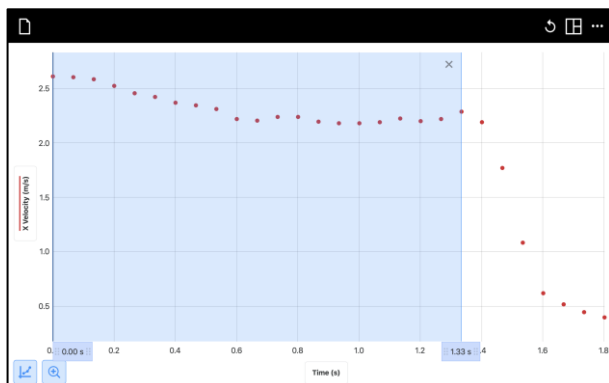
**TIP!** You cannot use *Interpolate* and *Tangent* at the same time. Choosing one de-selects the other.




### Viewing Statistics

Use the Statistics tool to calculate statistical attributes based on your data. Displayed values include number of points, mean, standard deviation, minimum, maximum, and range. Statistics for all plotted columns are calculated.

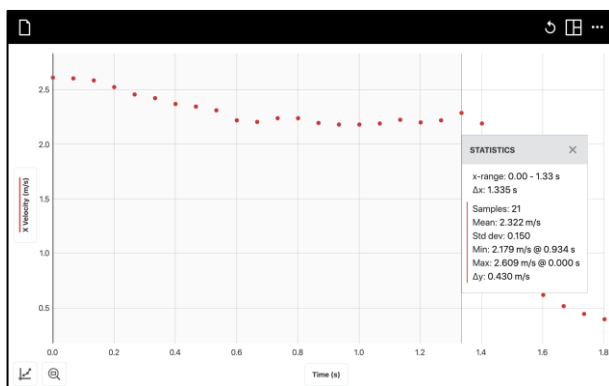
If desired, select a region of data. If a region of data is not selected, the Statistics tool uses all data in the calculation.



Click or tap  and select View Statistics. Statistics for all plotted columns on the graph are calculated and displayed in the Statistics details box.


To dismiss the Statistics box, click or tap the close button, ×.

**TIP!** You can slide the Statistics box up and down the right region boundary.

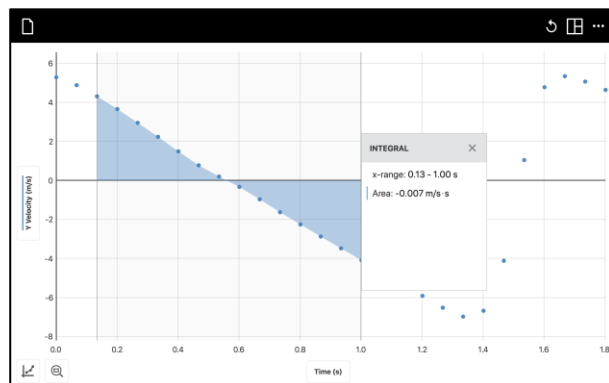


## Viewing Integral

Use the View Integral tool to calculate the numerical integral (area) associated with your data.


Select a region if desired. Click or tap  and select View Integral to find the integral.

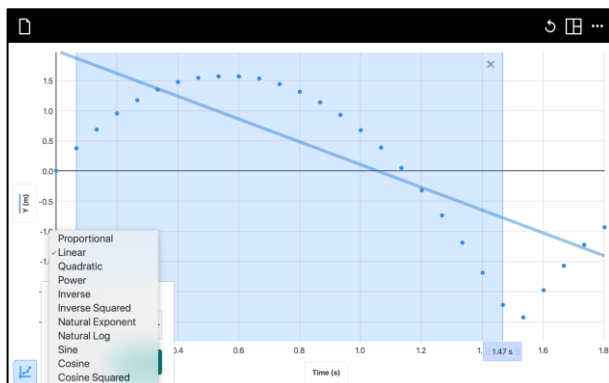
The associated area is shaded and the value is displayed. Regions above the horizontal-axis (x-axis) are positive, while regions below are negative. Areas for all plotted columns are calculated and displayed in the Integral details box.



## Applying a Curve Fit

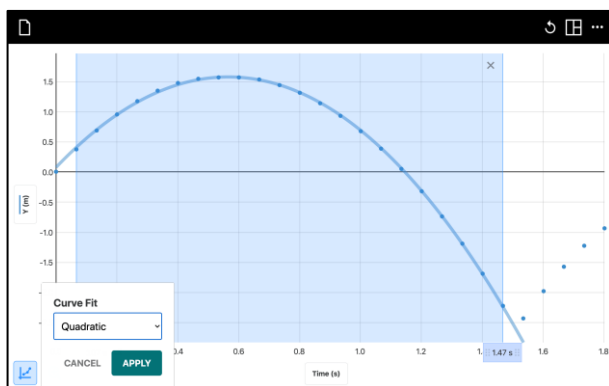
Use the Curve Fit tool to find a mathematical model that fits your data. Select a region first to fit a section of your data. When you select the tool without first selecting a region, all of the data are used to determine the fit model.


Click or tap  and select Apply Curve Fit to find the equation of the best-fit curve based on your data.



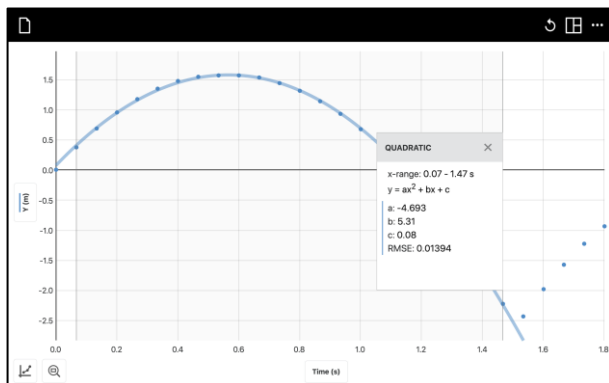
Curve fit models include Proportional, Linear, Quadratic, Power, Inverse, Inverse Squared, Natural Exponent, Natural Log, Sine, Cosine, and Cosine Squared.

Select a curve fit model to preview the fit to your data.



Click or tap  to display the curve fit equation and coefficients. Curve fits for all plotted columns are calculated.


The curve fit details box includes the RMSE (root mean square error), a measure of how well the fit matches the data. Linear curve fits also show the correlation coefficient ( $r$ ) associated with the linear fit.



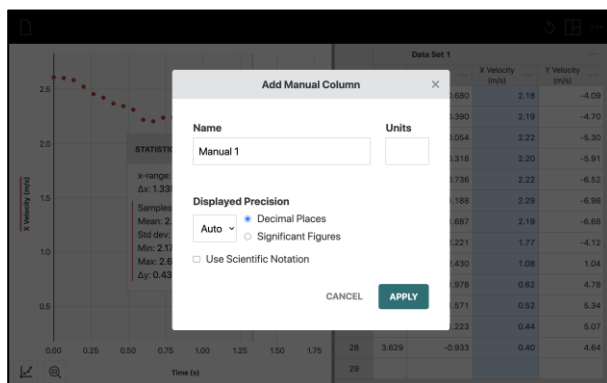
## Adding Additional Columns

### Adding a Manual Column

Add manual columns to bring in data from other files or data found on the internet to compare with your data.


From the data table or y-axis setup box, click or tap  next to an existing column. Choose Add Manual Column to create a new manual entry column.

You can modify the column name, add units, and adjust the display precision of the new column as desired. Either type data into the new column, or paste data from another file.

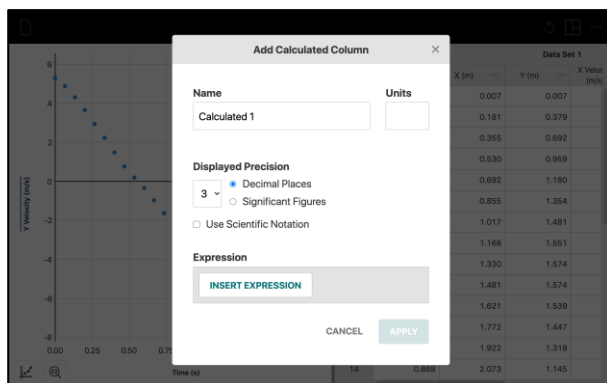


### Adding a Calculated Column

Calculated columns are columns with values that are based on other columns through a mathematical formula. For example, you might define a calculated column as the inverse square of another column, or you might calculate the square root of the sum of the squares of columns to create a magnitude column. You might even use calculated columns to create potential and kinetic energy columns from position and velocity columns.

From the data table or y-axis setup box, click or tap  next to an existing column. Choose Add New Calculated Column to create a new column.

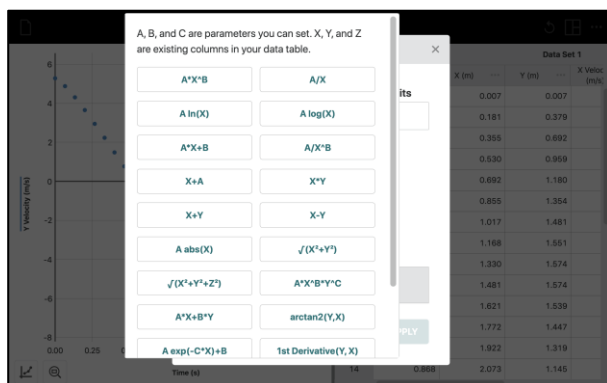
You can modify the column name, add units, and adjust the display precision of the new column as desired.



Click or tap  to view your expression options.

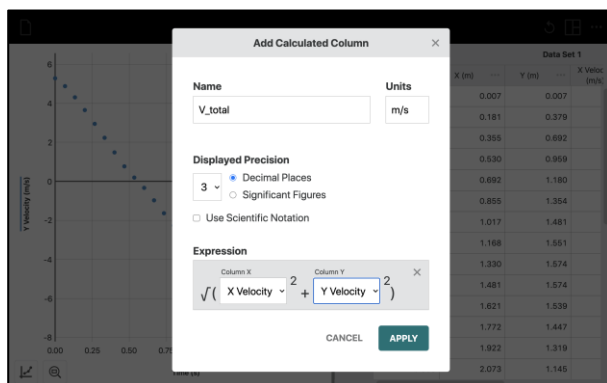
Select the desired expression to use for your calculated column.

The full list of available expressions is provided in the Available Expressions section. **TIP!** *A and B represent constants. X, Y, and Z represent data columns from your data table.*



The column from which you accessed the column tools is used in the calculated column expression. Adjust the columns and parameters as desired.

**TIP!** The new calculated column appears to the right of the column used to access the column tools.



### Available Expressions

The calculated column expressions available in Vernier Video Analysis are displayed in the graphic to the right. These are the same options available in Vernier Graphical Analysis; however, Vernier Video Analysis also includes the following:

- $X+Y$ , which adds two columns together. For example, if you have calculated columns for kinetic energy and gravitational potential energy, adding these columns gives the total mechanical energy.
- $\sqrt{(X^2 + Y^2)}$ , which gives the magnitude of a two dimensional vector, or in the case of circular motion it gives the radius when the origin of the axes is placed at the axis of rotation.
- $\arctan2(Y,X)$ , which gives the angle in the  $xy$  plane relative to the positive  $x$  axis. Its value is in radians.


The latter two expressions are useful for analysis of rotational dynamics.


A, B, and C are parameters you can set. X, Y, and Z are existing columns in your data table.



## Managing the Data


### Deleting Columns


From the data table or y-axis setup box, click or tap  next to an existing column. Choose Delete Column to remove Manual or Calculated Columns. Position, velocity, and time columns cannot be deleted.

Deleting a column cannot be undone. Click or tap  to confirm the deletion.

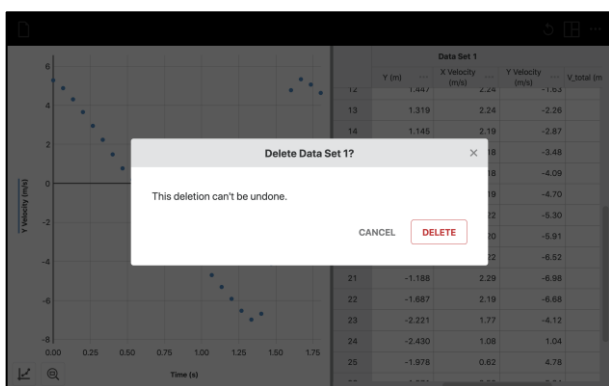
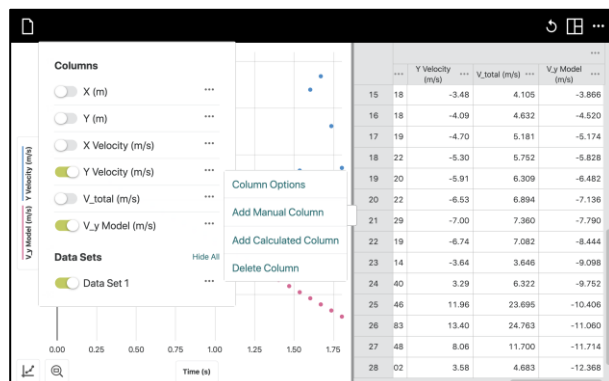
**TIP!** Since data sets are symmetric, deleting a column from one data set removes the corresponding column from all data sets.

### Deleting Data Sets

From the data table or y-axis setup box, click or tap  next to an existing data set. Choose Delete Data Set to remove a data set.


Deleting a data set cannot be undone. Click or tap  to confirm the deletion.


**TIP!** This is a convenient way to delete all data points and start over with analysis, if necessary.



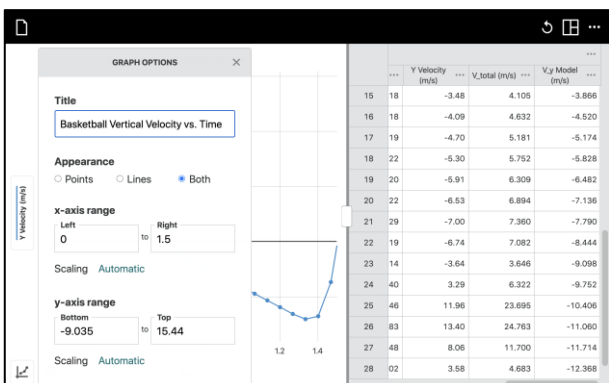
## Changing Graph Appearance

### Changing the Graph Style

Click or tap  and choose Edit Graph Options to access the graph configuration tools.

Adjust the appearance as desired. Click or tap the close button, , to dismiss Graph Options.

**TIP!** When displaying multiple graphs, changes to the Graph Options only apply to the graph from which the tool is accessed and are not automatically applied to the other graphs.

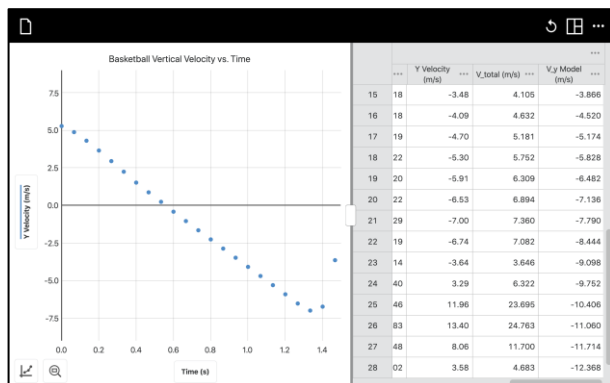




### Points

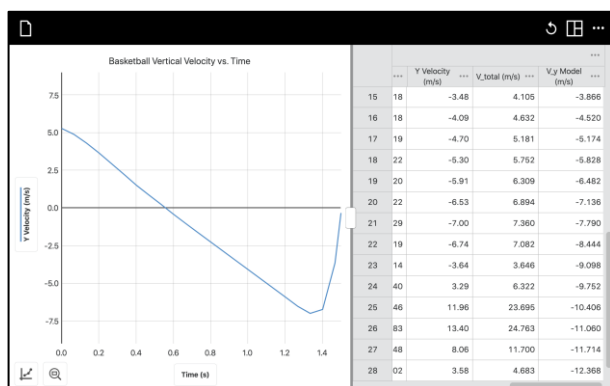
Choose Points to show data as unconnected dots.

This is the default option.



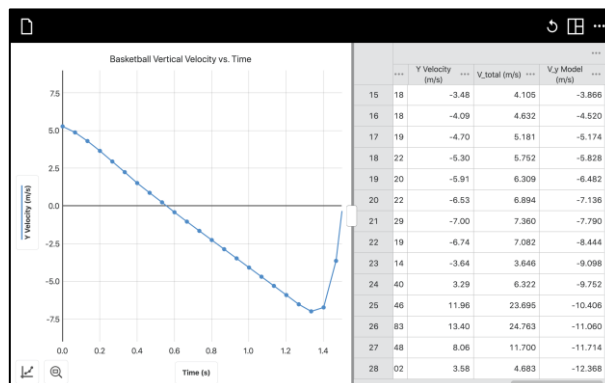
### Lines

Choose Lines to show linear segments drawn between the data points.



### Both—Points and Lines

Choose Both to show data as dots connected by linear segments.

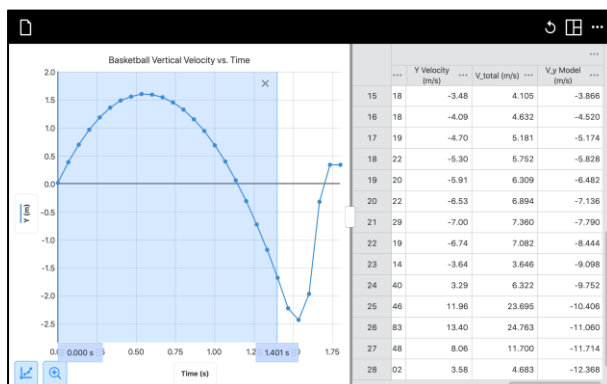



## Scaling the Graph

### Zoom to a Selected Region

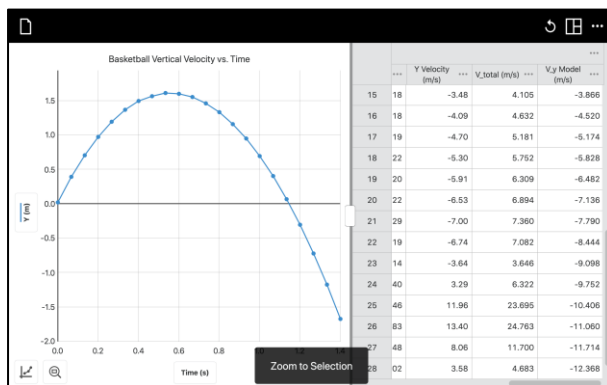
To scale the graph to a specific section of your data, click-and-drag or touch-and-drag across the graph to select the desired region.

**TIP!** You can click-and-drag or touch-and-drag the boundaries of a selected region to adjust the region as needed.

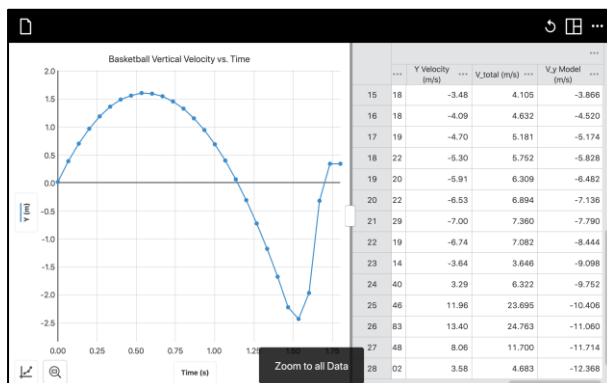


When a region is selected, click or tap  to rescale the graph to fit the selection.

The left and right boundaries match the selected region. The top and bottom boundaries automatically adjust to show all data within the region.



You can click or tap  again to rescale the graph to fit all data.




### Panning the Graph

Click-and-drag or touch-and-drag near one of the axes to pan or move the graph without changing the scaling. Starting near the horizontal axis (x-axis) pans the graph horizontally. Starting near the vertical axis (y-axis) pans the graph vertically.

**TIP!** Touch-screen devices can use a two-finger pinch gesture to pan and rescale the graph.



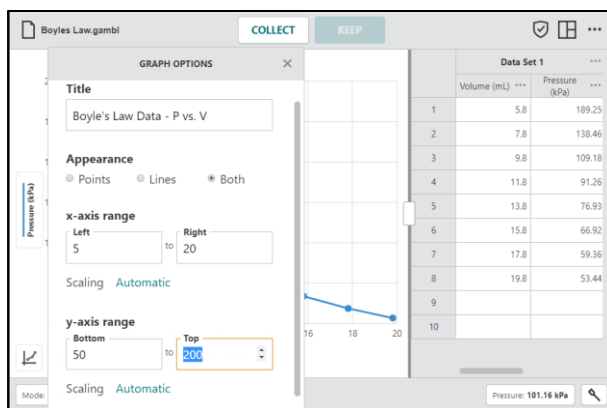
### Manual Scaling

Click or tap  and choose Edit Graph Options to access the graph configuration tools.

Manually configure the x-axis and y-axis ranges to display the data and adjust the scaling as desired. Click or tap the close button,  $\times$ , to dismiss Graph Options.

#### Scaling—Automatic

This default option allows the graph to scale larger during data collection to ensure all data points are visible.



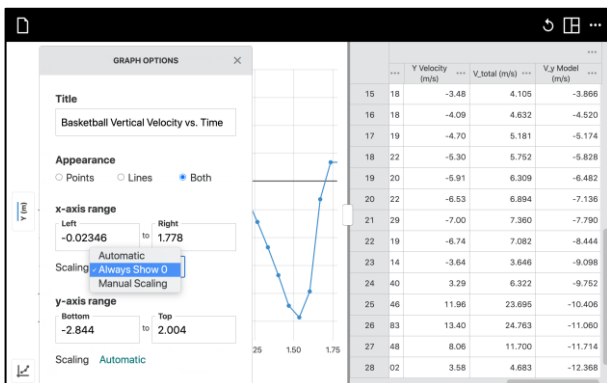
**TIP!** Manually entered range values are not respected when the scaling option is set to Automatic.

#### Scaling—Always Show 0

This option scales the graph to include 0 for that axis. This setting does not change the automatic behavior related to scaling the graph larger but is respected when you manually autoscale the graph.


#### Scaling—Manual


This option disables the automatic behavior related to scaling the graph larger during collection but is not respected when you manually autoscale the graph.



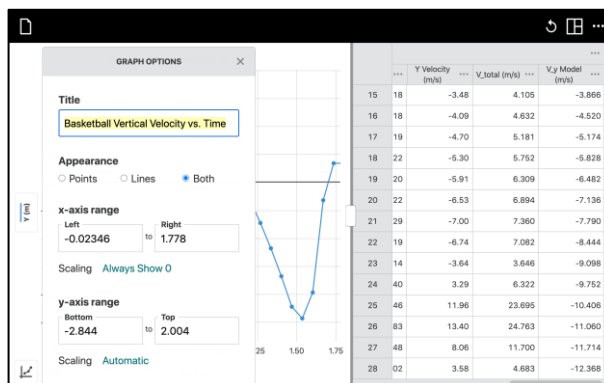
## Labeling the Graph

### Adding a Graph Title

You can choose to add a title to your graph. Click or tap  and choose Edit Graph Options to access the graph configuration tools.


Add or edit the graph title as desired. Click or tap the close button, , to dismiss Graph Options.


The title appears centered above the graph.

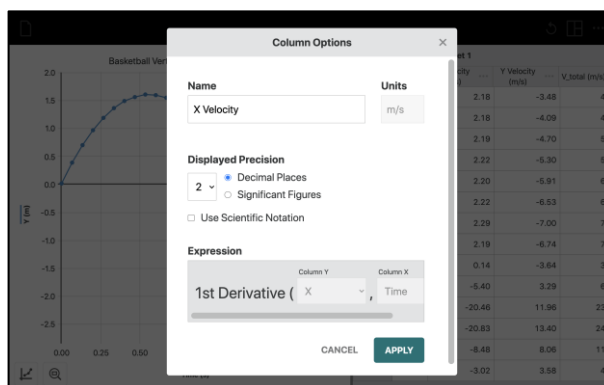


### Modifying Axis Labels

The axis labels are populated from the column names. You can change the labels by changing the names of the columns.


Click or tap the y-axis label you want to change. Click or tap  next to the column you want to change and choose Column Options.

Change the column name as desired. Click or tap  to save the changes.




To change the x-axis label, access the column options for that column from the data table or temporarily plot the column on the y-axis.

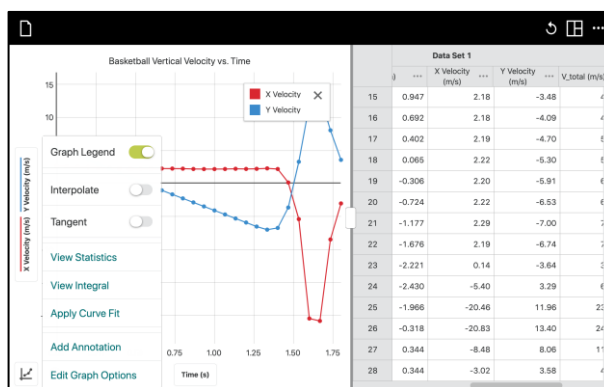
### Adding a Graph Legend

Click or tap  and select Graph Legend.

When selected, a box showing the color used for each column plotted from each data set is displayed on the graph.


Click-and-drag or touch-and-drag the legend to reposition it on the graph.

To dismiss the legend, click or tap the close button, .




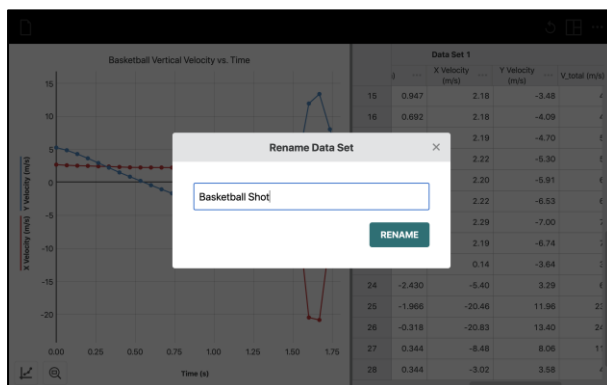
### Rename Data Sets

While not shown directly on the graph, data set names are shown in the y-axis graph setup box and in the Graph Legend.

Click or tap the y-axis label. Click or tap  next to the data set for which you want to change the name.


Choose Rename Data Set to change the default data set name.

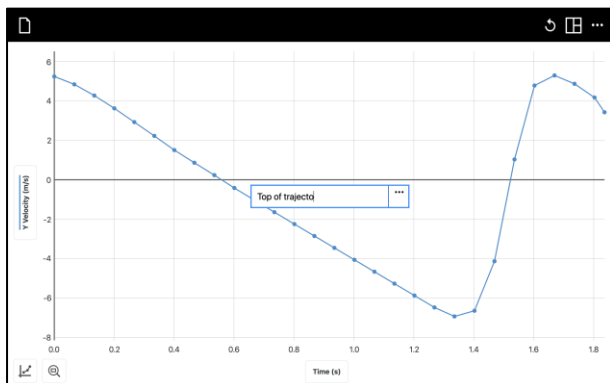
Click or tap  to save the data set name.



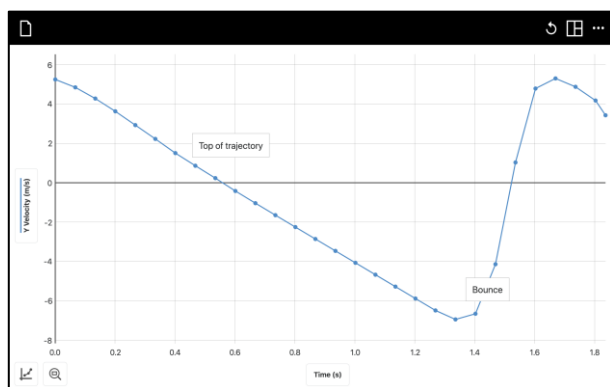
### Add Annotations

You can add text annotations to your graph to label key points or provide information about the data.


Click or tap  and choose Add Annotation to add text labels to your graph. Edit the text as desired.

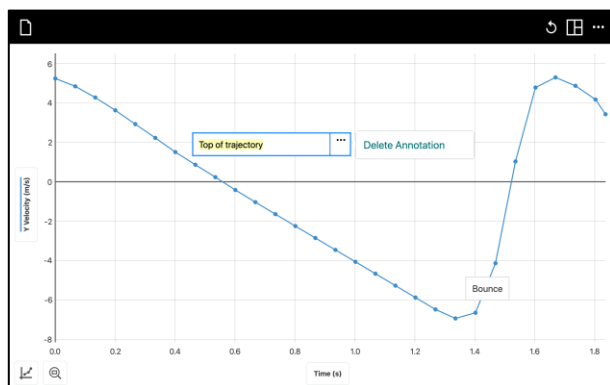


Click-and-drag or touch-and-drag an annotation to reposition it on the graph.




Click or tap an existing annotation to edit the text.

Click or tap  to delete the annotation.



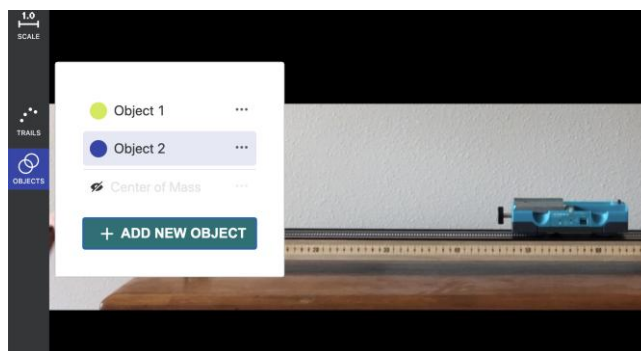
## Center of Mass

When two or more objects have been tracked, Vernier Video Analysis can calculate the center of mass with user input for mass. This may be useful in investigating collisions in one or two dimensions.

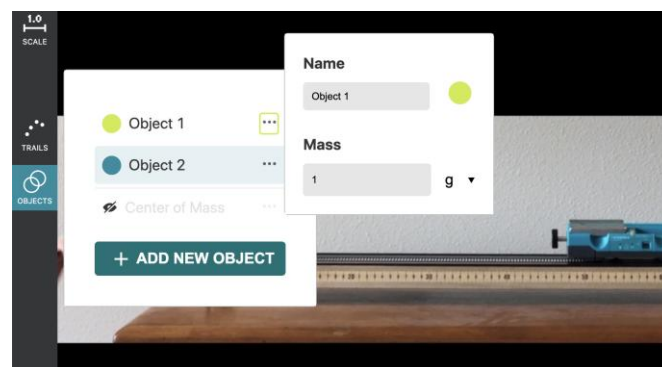
To work with the Center of Mass function, click or tap the Objects icon,  OBJECTS.


When you click or tap on the Add New Object button, an additional object will be added with a different dot color indicated. Change the dot color by clicking on it and choosing a new color.

You can return to any point series for marking by selecting it from the list.



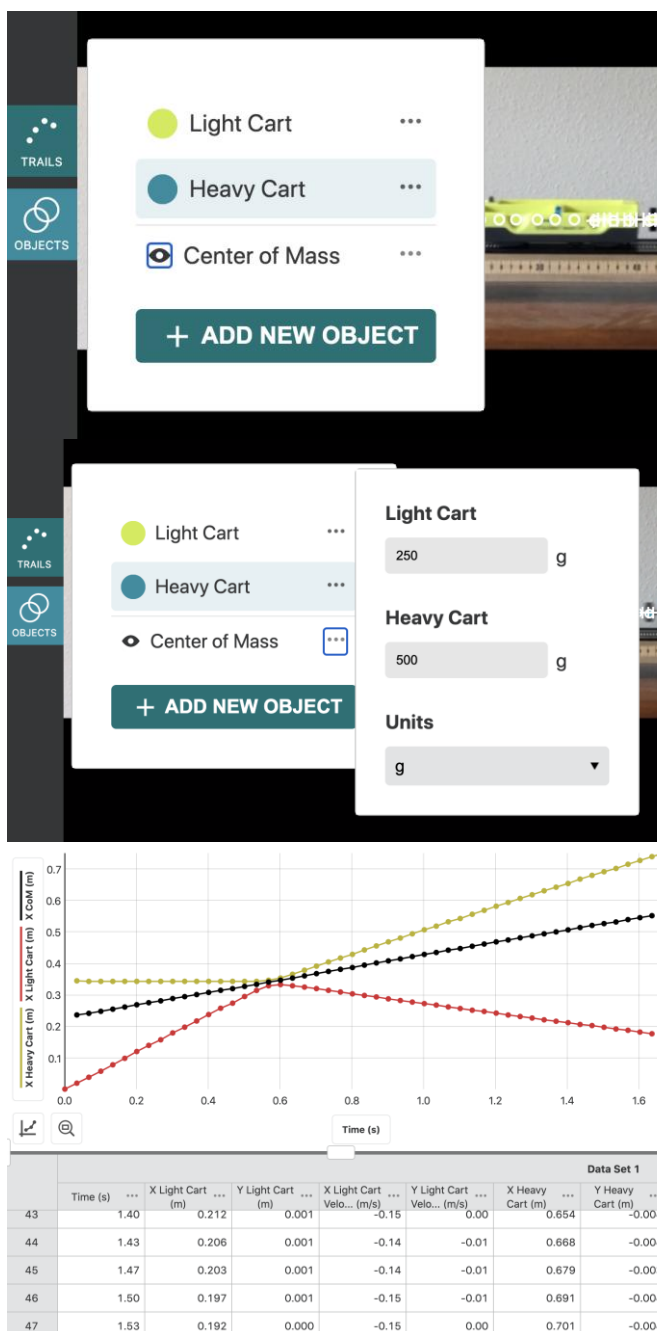
Use the three dots menu to the right of each object to change the name and the mass of the object



Click or tap the eye icon, , to turn on the Center of Mass view to see the location of the center of mass, marked with a + symbol.


In the three dots menu for the Center of Mass option, you can revise the masses of the objects and you can change the units for mass, just as you can for each object individually.

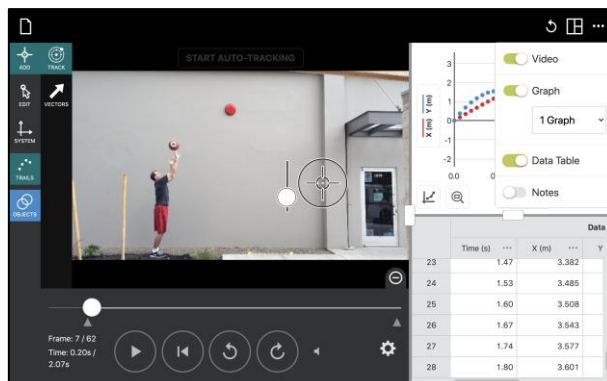
Changing the names of the objects changes the column names and the graph display names. Columns of both X and Y center of mass data are created in the data table and may be displayed on the graph.



## Configuring the View

Vernier Video Analysis automatically displays a view consisting of the video, a graph showing vertical and horizontal position, and a data table. You can use this recommended view or modify the view using the options provided.

Click or tap , then modify the options as desired.

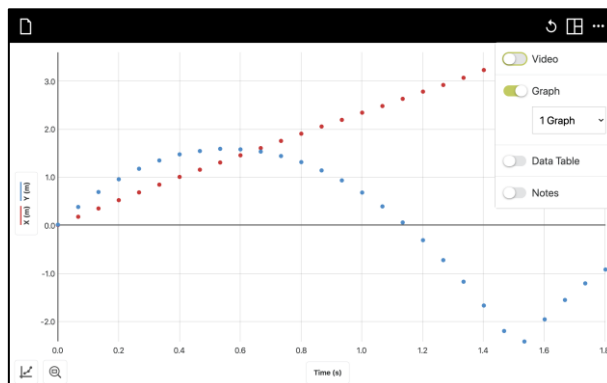


### Using Only a Single Display Element

For a full-screen view of a Graph, Data Table, or Meter, use only one of the options. The graph element can show one or two graphs.

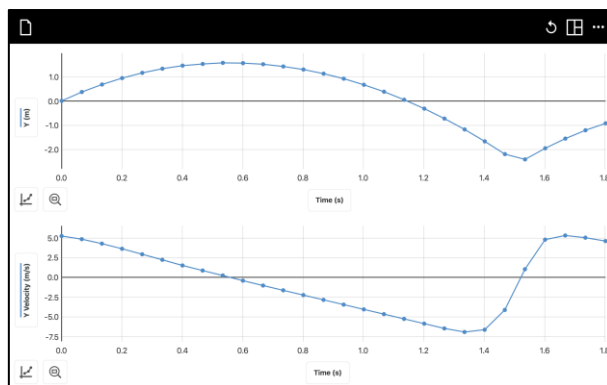
#### 1 Graph

This is the default graph.



#### 2 Graphs

Use this view to stack position vs. time and velocity vs. time graphs, for example.





## Data Table

This view shows the data table.

	Time (s)	X (m)	Y (m)	X Velocity (m/s)	Y Velocity (m/s)
16	1.00	2.345	0.683	2.16	-4.06
17	1.07	2.483	0.395	2.17	-4.66
18	1.13	2.633	0.061	2.21	-5.26
19	1.20	2.783	-0.307	2.18	-5.87
20	1.27	2.921	-0.722	2.20	-6.47
21	1.33	3.071	-1.171	2.27	-6.93
22	1.40	3.232	-1.667	2.17	-6.64
23	1.47	3.382	-2.198	1.75	-4.13
24	1.53	3.485	-2.415	1.07	1.04
25	1.60	3.508	-1.955	0.61	4.78
26	1.67	3.543	-1.551	0.51	5.31
27	1.74	3.577	-1.208	0.44	5.03
28	1.80	3.601	-0.918	0.39	4.60
29					

## Notes

This element adds a note field. Click or tap on the eye icon or pencil icon to toggle between edit mode and view mode.

While in edit mode, text is shown with simple markup elements. In view mode, the text is shown larger and includes formatting.

Images and links can be added while in edit mode.

	Time (s)	X (m)	Y (m)	X Velocity (m/s)	Y Velocity (m/s)
16	1.00	2.345	0.683	2.16	-4.06
17	1.07	2.483	0.395	2.17	-4.66
18	1.13	2.633	0.061	2.21	-5.26
19	1.20	2.783	-0.307	2.18	-5.87
20	1.27	2.921	-0.722	2.20	-6.47
21	1.33	3.071	-1.171	2.27	-6.93
22	1.40	3.232	-1.667	2.17	-6.64
23	1.47	3.382	-2.198	1.75	-4.13
24	1.53	3.485	-2.415	1.07	1.04
25	1.60	3.508	-1.955	0.61	4.78
26	1.67	3.543	-1.551	0.51	5.31
27	1.74	3.577	-1.208	0.44	5.03
28	1.80	3.601	-0.918	0.39	4.60
29					

**B I Paragraph** In this experiment, a basketball has been thrown. We will analyze the vertical and horizontal motion of the basketball separately.

## Using Multiple Display Elements

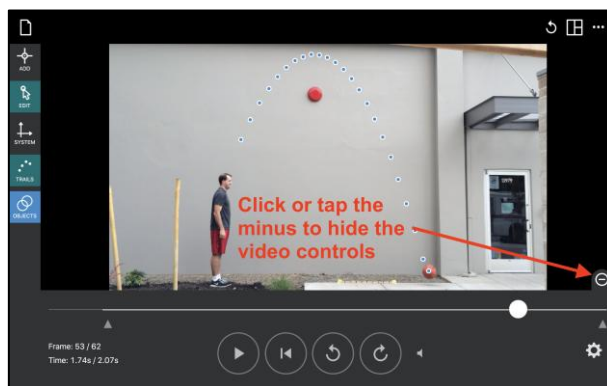
You can choose to show two, three, or all four elements at once. The splits can be adjusted by dragging the handle located on the separating lines.

This view shows all four elements at once. Adjust the browser window to fill the screen for best results.

The screenshot shows a multi-pane view. At the top left is a video frame of a basketball being thrown. Below it is a graph of Y (m) vs Time (s) showing a parabolic path. To the right is a note field with the text: "In this experiment, a basketball has been thrown. We will analyze the vertical and horizontal motion of the basketball separately." At the bottom right is a data table:





	Time (s)	X (m)	Y (m)
16	1.00	2.345	
17	1.07	2.483	
18	1.13	2.633	
19	1.20	2.783	
20	1.27	2.921	
21	1.33	3.071	

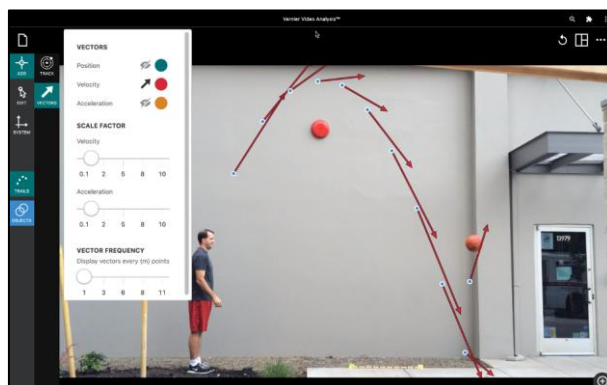
**TIP!** Use the minus symbol in the video element to hide the video playback controls. This makes the video itself larger.



## Vector Display

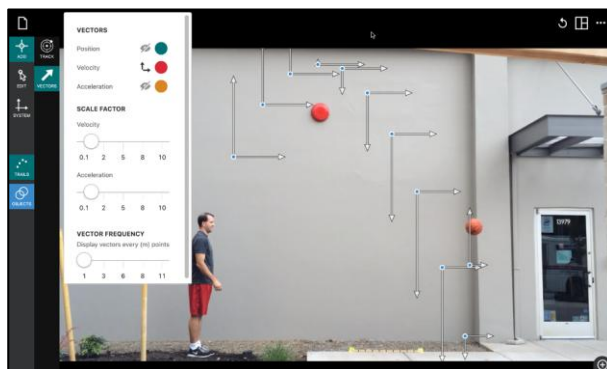
Vernier Video Analysis is able to superimpose position, velocity, and acceleration vectors on a video with a tracked object. These vectors are determined using the chosen coordinate system and their relative magnitudes from the velocity and acceleration columns. An acceleration column is created as needed for vector displays.

To enable vector display after tracking an object, click or tap Add, and then Vectors. A control panel allows you to show or hide position, velocity, and acceleration vectors and their Cartesian components. Click or tap the eye icon to cycle through off, , vector and components, , resultant vector only, , and components only, .



Because velocity and acceleration units are incommensurate with the spatial units of the video, the scale of the vectors drawn on the video is arbitrary. Sliders for the magnitude of velocity and acceleration vectors can be adjusted to achieve scales that allow vectors to be easily sized so that they are neither too short nor off screen.

The Vector Frequency slider allows the choice to display vectors on only a subset of points. Choose a setting to allow easy viewing of vectors without overlap.





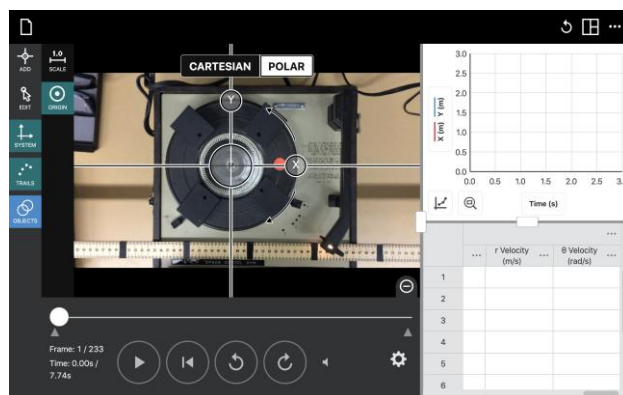
## Notes on the use of vector displays

- Because the screen can quickly become cluttered with points and vectors, the vector feature is most often used when tracking a single object.
- Also due to visual clutter, when studying vector displays you may want to hide the data table and graph using the View menu. It may also be helpful to hide the video playback controls as shown in these screenshots.
- There are two ways to control the frequency of vector plotting. One is to mark fewer frames of the video, and the other is to use the Vector Frequency control. These choices do not have quite the same effect due to how velocity and acceleration are calculated.
- The velocity and acceleration vectors are drawn proportional to the values in the data table. Because these values are numerical derivatives of the position data, they are *not* instantaneous velocities or accelerations. Instead, they represent an average based on the position values on either side of the point carrying the vector. When an object suffers a sudden direction change (as in a bounce or impact) the vectors drawn adjacent to the moment of the change may not be what you expect. They may be based on position values on the other side of the change. You can reduce this effect by marking more frames.
- Position vectors are drawn from the origin to the object, and therefore change as the origin is changed.
- The vector component directions depend on your choice of coordinate system rotations. If you rotate your Cartesian coordinate system, the components are calculated and drawn based on this rotated system.
- Vectors are only displayed for drawn points. That is, if trails are off or the current time on the video is earlier than any marked points, no vectors are shown.

## Using Polar Coordinates

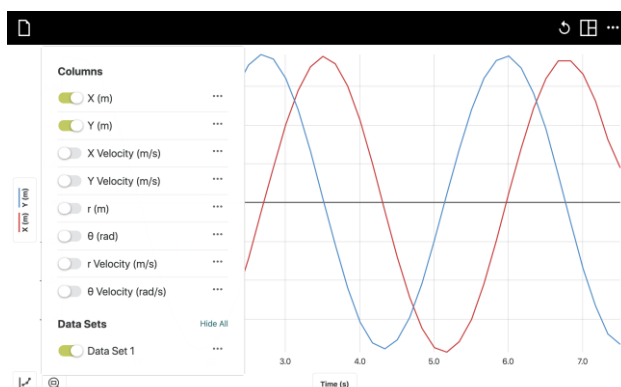
Polar coordinates are useful when examining rotational kinematics.

To use polar coordinates, select System, , then Origin, . Click or tap Polar.




When polar coordinates are selected, in addition to the X and Y positions and velocities, Vernier Video Analysis creates calculated columns for radius (r), angular position ( $\theta$ ), radial velocity, and angular velocity. Units are in radians.

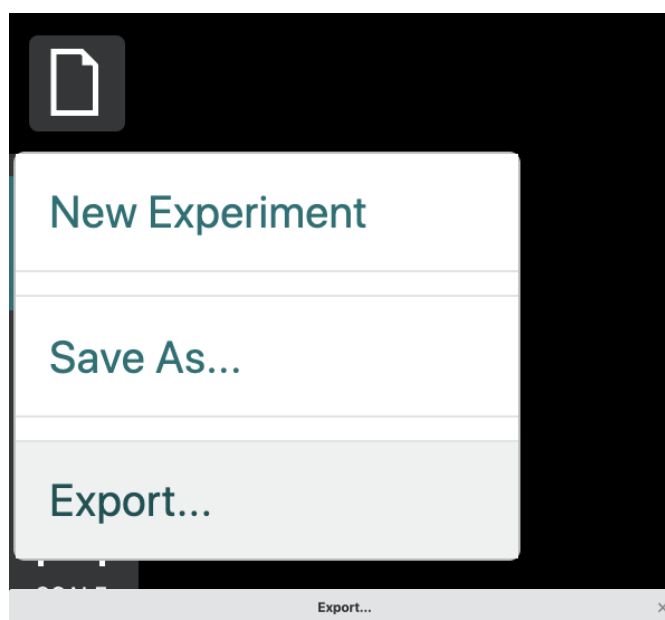
Angular position is calculated using the arctan2 function. The angular position resets to 0 upon reaching  $2\pi$  radians.



## ADDITIONAL INFORMATION

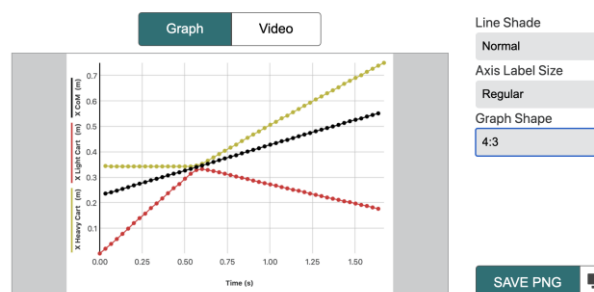
### Export

Click or tap on the page icon, , in the upper left of the Video Analysis app to access the Export functions.

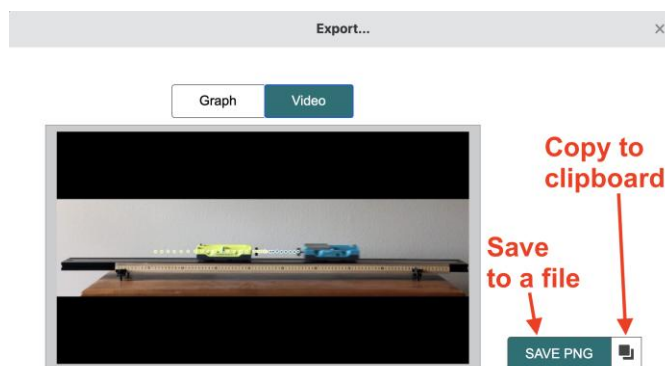


You can export either a graph image or a still video frame. The export can either be saved as a .png image file, or it can be saved to the clipboard to be pasted directly into a lab report.

For a graph, you can adjust the intensity of the lines on the graph, the relative size of the axis labels, and the aspect ratio.



When you choose to export a video frame, prepare by setting the video to a frame you would like to share, and add the scale, trails, or vectors as you prefer.



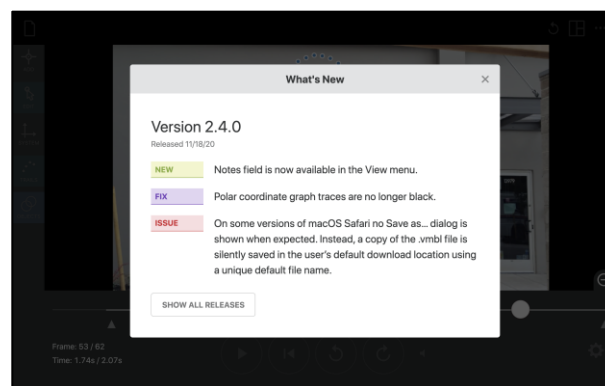
### Printing

You cannot print directly from Video Analysis. To print a Video Analysis file, use Export to create the desired file (.csv or .png). Print the resulting file using the print options available on your device.

### What's New

Click or tap from the top toolbar and choose What's New to view a summary of the new features and fixes available in the most recent version of Vernier Video Analysis.

Click or tap to see changes made in previous versions.



## V. FAQs

### I saved my file to a Google Drive. When I try to open it, why does it look like code?

In order to re-open a file in Video Analysis, first open the app. Then click or tap Open File and navigate to the location where the file is saved. Select the file and choose open. Note that files created by Video Analysis have the suffix .vmb1. Double-clicking a .vmb1 file will generally not launch the Video Analysis app, unlike some other applications.

### **I accidentally closed the browser window/tab while analyzing a video. Can I retrieve my data?**

If you try to close a tab with unsaved Vernier Video Analysis, the browser will warn that work is unsaved and ask to confirm you want to leave the tab. If you do leave the tab, your data will be lost. That data will have to be collected again. This is also the case if the browser or device crashes during your session, or if you quit the browser.

### **Can I make my video larger to make it easier to mark points?**

You can either change the view to video only, or you can resize the graph and data table by using the sliders on the boundaries of these elements. If you are using a large monitor, you can expand the size of the browser window to fill the screen. In addition, you can zoom in on the video to view only a portion of the image, allowing greater precision in marking points. Zoom in using pinch gestures on multitouch devices such as tablets and touchscreen Chromebooks.

### **How can I change the frame rate used for analysis?**

Click or tap on the gear icon under your video. This opens the Advanced Video Options. Adjust the frame rate as needed to correct for videos that do not play back at normal speed. For example, videos that play back in slow motion require a frame rate adjustment because the video plays back at one rate (usually 30 fps) but was taken at a higher frame rate. For more information about analyzing high speed video, see <https://www.vernier.com/til/3081>.

### **Which video formats are supported?**

Compatible file containers include .mp4 and .mov. These containers may hold videos compressed with incompatible codecs, so some of these files may not be usable. For example, iOS devices can collect videos in a high-efficiency format called HEVC. Many other devices, such as Chromebooks, cannot open these files. Record videos on Apple devices using the “Most Compatible” choice, available in Camera Settings. You can convert a video to the correct format using commonly available resources. For more information, see <https://www.vernier.com/til/1342>.

### **Do I need to update Vernier Video Analysis?**

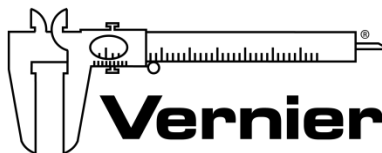
Vernier Video Analysis automatically updates when opened if there is a software update available and the device you are using is connected to the internet. There is no need to manually update the app.

### **What is planned for future releases of Vernier Video Analysis?**

- User-defined curve fitting on the graph
- User-defined calculated columns in the data table

### **Where can I find additional help?**

For up-to-date information, see <https://www.vernier.com/til/7037>



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