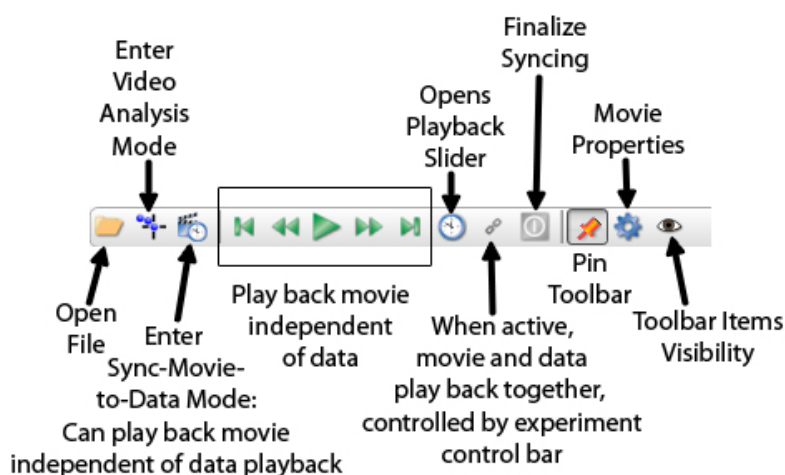


For this tutorial you should have PASCO Capstone already installed on your computer. Note that when you use your own created videos, your video format must be in .MP4. You can use online converters to easily change the file format.

Download the file “Video Analysis.cap” and double clicking it should open it up in Capstone. You should see a Movie Display and two graphs.

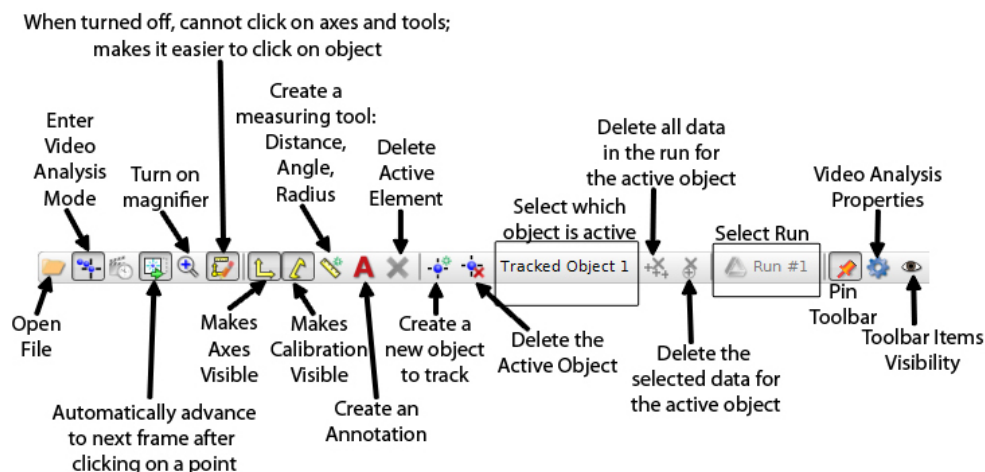
Below is an explanation of the items on the movie toolbar.



For this example, a movie file called "BallCartLevel" has already been opened. This is a slow motion movie of the ballistic cart launching a ball and catching it. Push the green play button in the movie toolbar to play the movie. (You may also press the space bar to toggle between “pausing” and “playing” the video.)

Enter Analysis Mode and Set Up for Tracking

Enter Analysis Mode by clicking on the button . Note that the toolbar changes (see above for an explanation of the new tools).



A new object is automatically created for you and as soon as you click in the movie to make it active, the next click on the video screen will be the first track mark for the object. (Note: Steps 1 and 2 below are not necessary for a regular 30 frames/second movie.)

1. Before you start clicking on the screen, since this is a slow motion movie, we need to tell it the proper number of frames per second (210 fps). Open the properties by clicking on the gear icon on the right end of the toolbar. You might need to click the >> to see the rest of the menu toolbar.
2. Under "Movie Playback", type in 210 for "Playback Frame Rate".
3. In the properties, under "Overlay", change the "Frame Increment" to 7. This will mean that the movie will advance 7 frames each time you click on a point (and, thus, your points will be $1/30^{\text{th}}$ of a second apart).
4. You can also rename "Tracked Object 1" to "Ball". To do this, make sure you are in the Video Analysis Mode and open the Properties and under "Tracked Object", change the name to "Ball".
5. On the top graph, select the ball's y-position vs. the ball's x-position.
6. On the bottom graph, select the ball's y-velocity vs. time.

Track an Object – Ball

1. Using the playback tools on the Experiment Control bar at the bottom of the page, advance the movie to the frame where the ball is coming out of the ballistic cart launcher.
2. Click on the magnifying glass to find the positions more accurately. Click in the movie to make it active and then start clicking on the ball to track it.
3. After tracking the ball, if you play back the movie you may want to decrease the playback speed on the Experiment Control bar to 1/8 speed.

Changing Track Points

If you decide you want to change one or more of the points that you have already made, use the playback controls on the Experiment Control bar to return to the frame of the point you want to change. The point will have a circle around it. Then click where you want the point to be. The point will be moved to the new location. Then you can use the playback controls to advance frames or you can continue to relocate points by clicking in each frame as it advances.

Note: If you have the Frame Increment set on 7, although clicking on the object advances the movie 7 frames, when you click the Previous (or Next) Frame button on the Experiment Control bar, it will only change by one frame at a time.


Calibration can be done (or re-done) at any time.



Click on the Calibration Tool and move its ends to endstops on the track. The distance between the endstops is 120 cm or _____ m. Open the Properties and under "Calibration Tool", set the "Real World Length" to 120 cm.

Track a Second Object



1. Now we want to track the cart. Push the "Create New Object" button . You can rename this "Tracked Object 2" to "Cart" in the same manner as you did for the ball.
2. Use the playback tools on the Experiment Control bar at the bottom of the page, advance the movie to the frame where the ball is coming out of the ballistic cart launcher, exactly on the same first point for the ball.
3. Click on the center of the top of the cart and track the cart until the ball goes back into it.

Adjusting the Axes: The axes can be moved or rotated at any time.



1. Click on the yellow dot near the end of the x-axis and drag it to rotate the axes until the x-axis is aligned with the track. Note that your graphs will change also.
2. In the movie analysis, click on the origin of the axes and drag the origin to the first analysis point for the ball.

Questions

1. What do you notice about the x velocity of the ball and the x velocity of the cart?
2. What does this experiment demonstrate about the direction of the component velocities of the ball and the cart?
3. Apply a linear fit to the y-velocity vs. time data for the ball and determine the acceleration due to gravity from the slope of the line. Use the percent error formula to determine if this video analysis value is acceptable.

$$\%_{error} = \left| \frac{\#_{experimental} - \#_{theoretical}}{\#_{theoretical}} \right| \cdot 100$$