

Title: Web cam usage in physics experiments

Date: May 27, 2006 10:00 AM


URL: <http://pirsa.org/06050019>

Abstract: <kw> web camera, video camera, precise experiments, video capture, technology, dartfish, vernier, logger-pro, video analysis, video acquisition. </kw>


Outline Slides

- 1 WEB CAMERA USAGE IN PHYSICS EXPERIMENTS
- 2 Focus Question:
  1. How can we make the physics experiments more interactive and more enjoyable?
  2. How can we use technology to make the topics?
  3. How can we use the technology to make the experiments more interactive?
- 3 Traditional method is
- 4 Technology
- 5 New Full stack
- 6 Application


# WEB CAMERA USAGE IN PHYSICS EXPERIMENTS



*Newton*



*The innovative way of understanding & learning Physics concepts*



*by Anjuli Ahojja*

Click to add notes



# WEB CAMERA USAGE IN PHYSICS EXPERIMENTS



*Newton*



*The innovative way of  
understanding & learning  
Physics concepts*

*by  
Anjuli Ahooja*



# WEB CAMERA USAGE IN PHYSICS EXPERIMENTS



*Newton*



*The innovative way of  
understanding & learning  
Physics concepts*

*by  
Anjuli Ahooja*



# Focus Questions?



# Focus Questions?

1. How can we make the physics experiments more precise and more accurate?



# Focus Questions?

1. How can we make the physics experiments more precise and more accurate?
2. How can we use technology to make this happen?



# Focus Questions?

1. How can we make the physics experiments more precise and more accurate?
2. How can we use technology to make this happen?
3. Last, but not the least, how to make experiments more fun for students?





# Traditional Method (s)

- Use
  - eye
  - stop watch
  - meter stick
  - .....



# Technology

- Sensors
- Data Acquisition Software
- Simulations
- .....

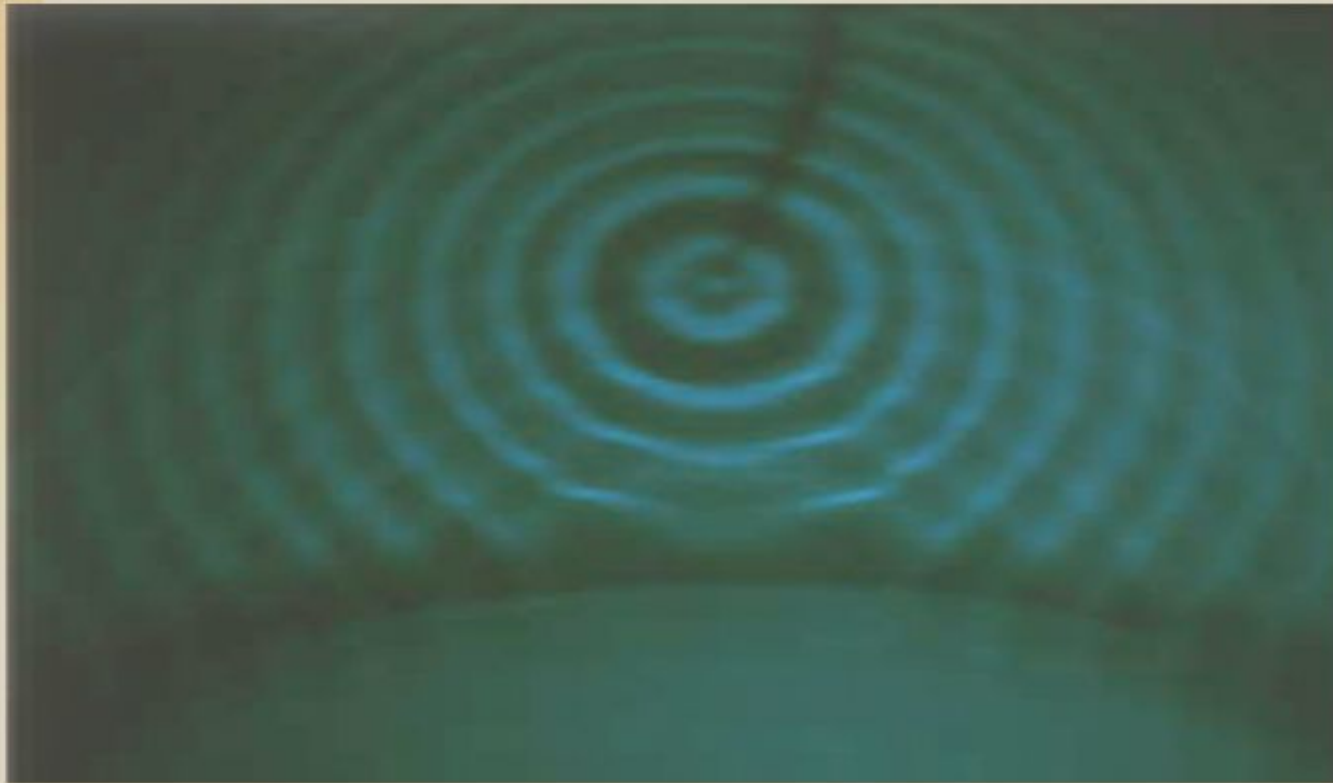


# How it all started?

- Ripple tank and still digital camera
- Digital video camera



# Ripple tank



# Ripple Tank

- Take videos of the ripple tank
- Observe the changes in wavelengths with change in frequency, angle, depth etc
- Observe the changes when obstacles are placed in the tanks



# Digital Video Camera

- Projectile motion
- DartFish
- <http://www.dartfish.com>
- Download the software free for 30 days .....



# Logger-Pro Video Analysis

- Vernier (Logger-Pro) recommended using a web camera for its video analysis software



# Advantage Web Camera

- Cheaper
- More robust
- Easy to use





# Follow up Experiments

- Projectile Motion
- Circular Motion
- Collisions
- Understanding Acceleration



# Projectile Motion

- Method
- Take videos of a projectile launcher or
- Take videos of a basketball shot
- Analyze the videos using Dartfish or Logger Pro video analysis tool
- How to plot points on the graph (Logger Pro)



# Projectile Motion

- Define the scale by keeping a meter rule in the same area
- Choose the required axes from the graph options
- plot the points by moving the video frame to frame
- Observe the graph
- Multiple graphs also possible ( $y - t$ ,  $x - t$ ,  $y - x$  or )



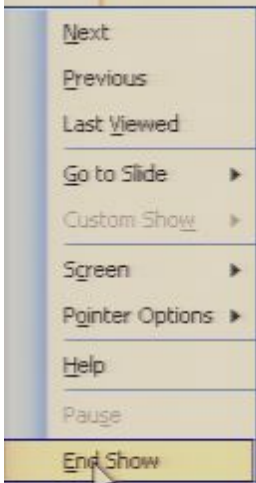
# Circular Motion

- More accurate data for time
- Response time reduced
- More precise data for number of revolutions as points are plotted on the video
- More precise time period measured



# Circular Motion

- More accurate data for time
- Response time reduced
- More precise data for number of revolutions as points are plotted on the video
- More precise time period measured





Outline Slides

- 14 Circular motion
- 15 Circular motion
- 16 Collision (Elastic or Inelastic)
- 17 Understanding acceleration
- 18 Understanding acceleration using a Graph
- 19 A short paper using Web Camera

# Circular Motion

- More accurate data for time
- Response time reduced
- More precise data for number of revolutions as points are plotted on the video
- More precise time period measured

May 27, 2006

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Click to add notes



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- Additional Graphs
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- Picture...
- Parameter Control
- Meter
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- Text Annotation
- Rectangle
- Oval
- Video Capture...



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- Graph
- Additional Graphs
- Table
- Movie...
- Picture...
- Parameter Control
- Meter
- Text
- Text Annotation
- Rectangle
- Oval
- Video Capture...**

Navigation icons: Home, Back, Forward, Print, Zoom In, Zoom Out, X=, M=, STAT, R=, f(x)=, Clock, Collect



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### Video Capture



Start Capture

Take Photo

Options...

Set Up Camera...

Help

Status: Ready

Capture Duration: 10 seconds

Estimated File Size: 40 MB

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Video Capture



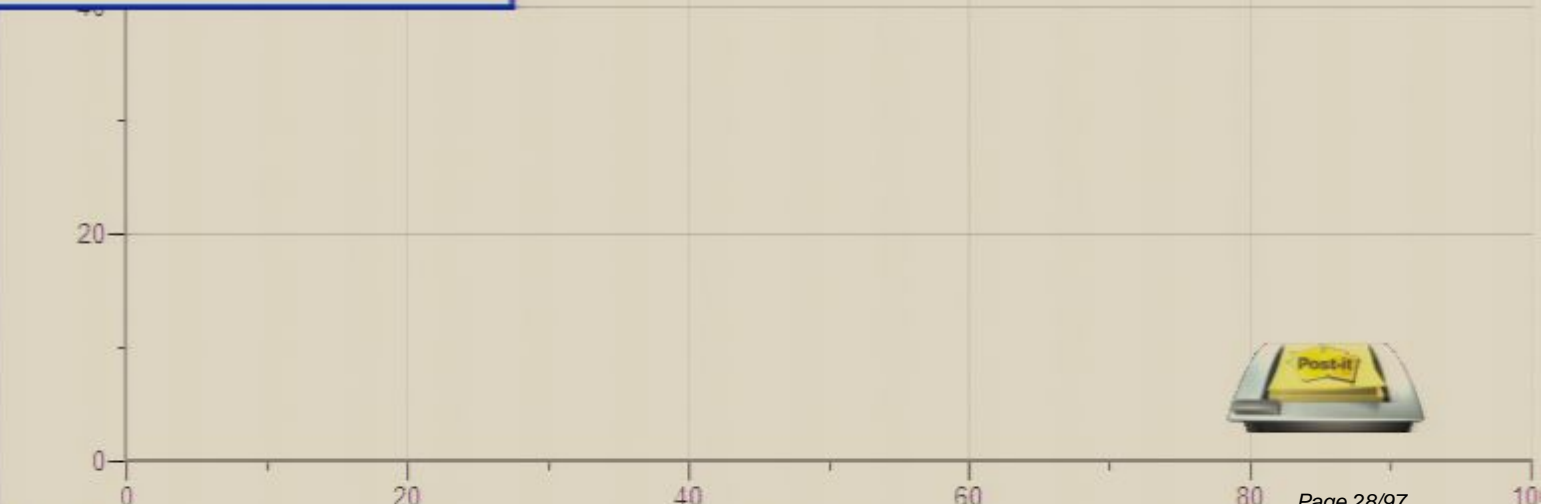
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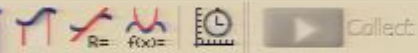


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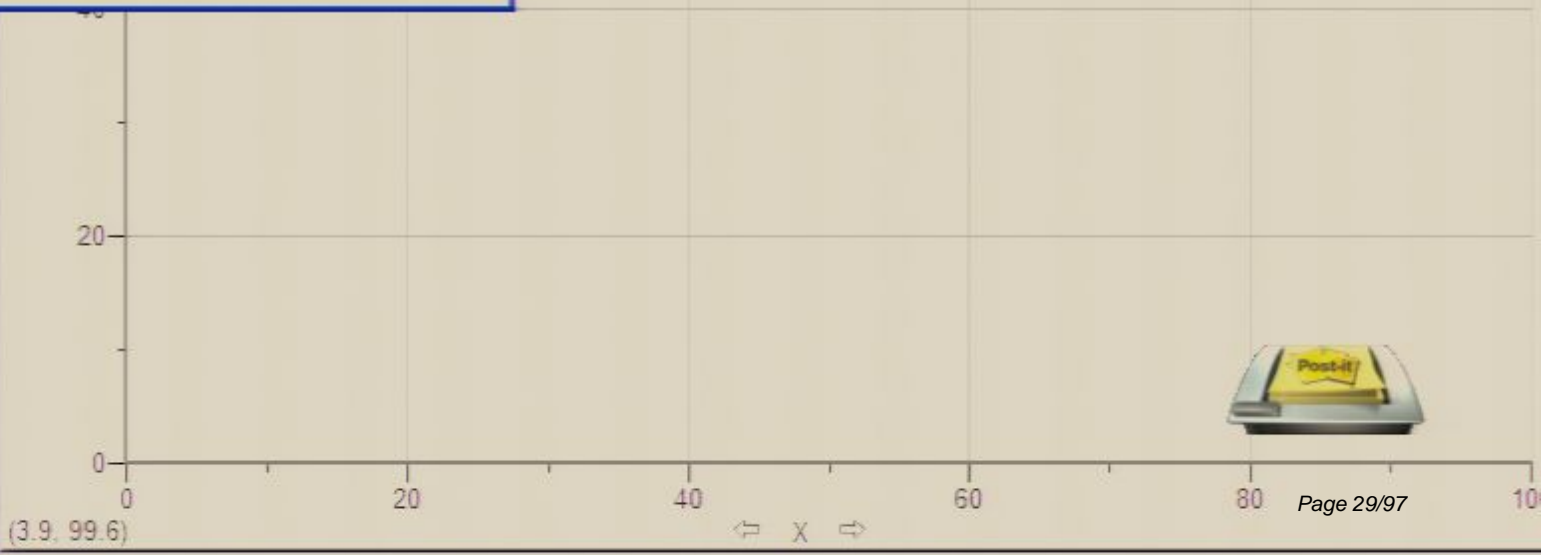
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### Video Capture



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### Video Capture



- Start Capture
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Video Capture



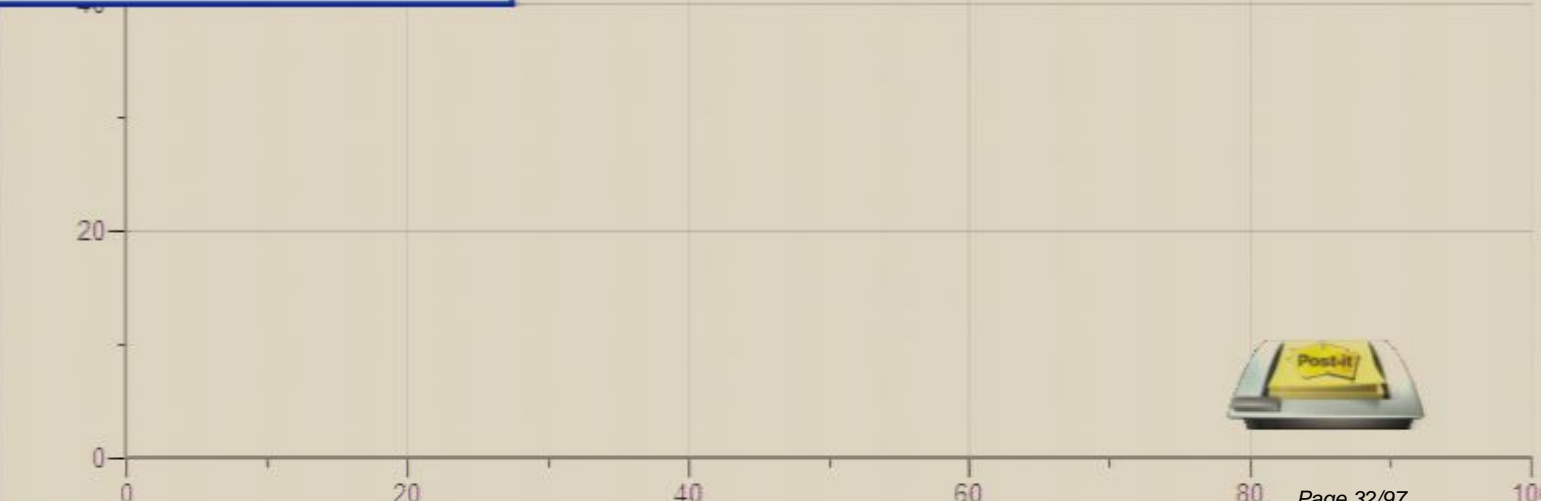
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Video Capture



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### Video Capture



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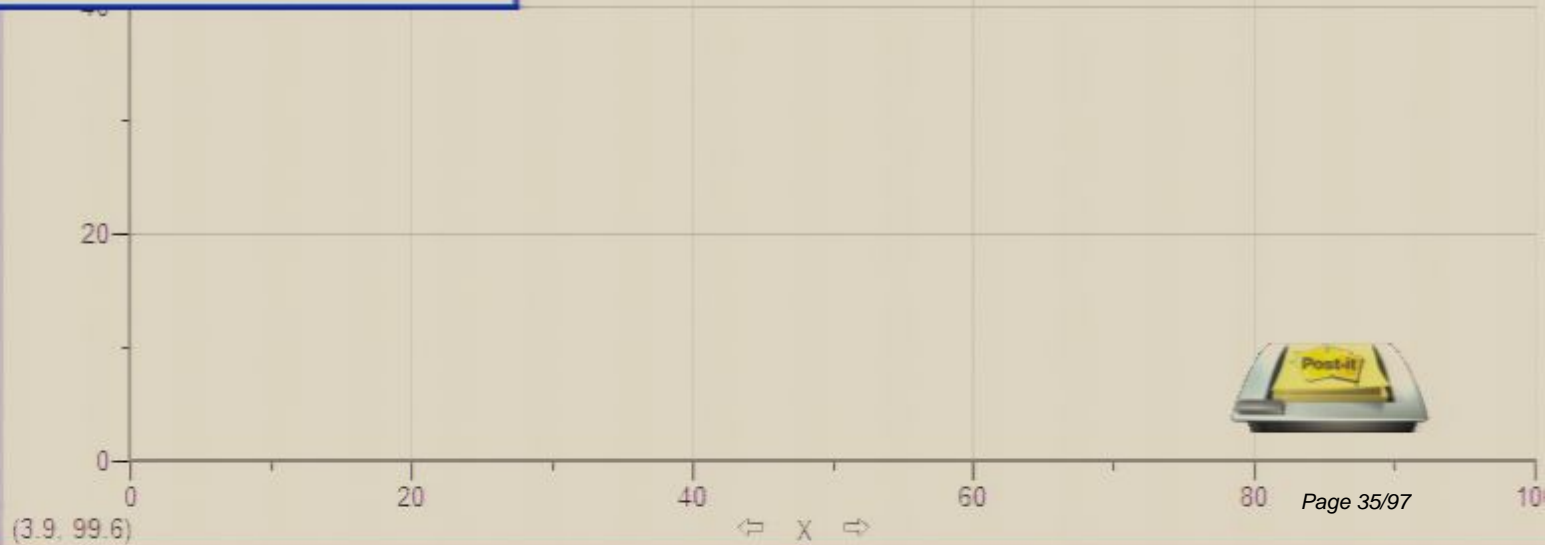
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Video Capture



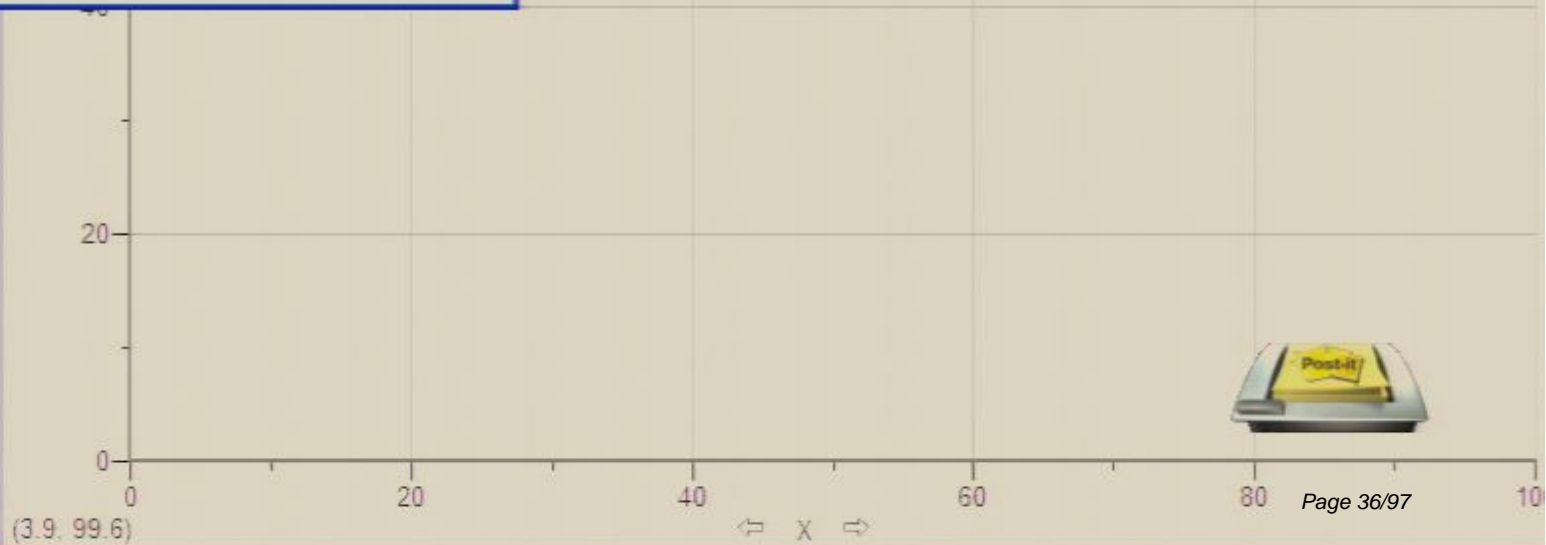
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Video Capture



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**Open**

Look in: Experiments

- \_Advanced Chemistry w Vernier
- \_Biology with Computers
- \_Chemistry with Computers
- \_Earth Science with Computers
- \_Human Physiology w Vernier
- \_Middle School with Computers
- \_Nuclear Radiation w Computers
- \_Physical Science w Computers
- \_Physics with Computers
- \_Real-World Math with Computers
- \_Water Quality with Computers
- Additional Physics
- Elementary Books
- GIS (Geographic Info System)
- Probes & Sensors
- Sample Data
- Sample Movies
- Tutorials

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**Open**

Look in: Desktop

- My Recent Documents
- Desktop
- My Documents
- My Computer
- My Network Places
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**Open**

Look in: OAPT

Shortcut to Basketball Shot.mov

My Recent Documents

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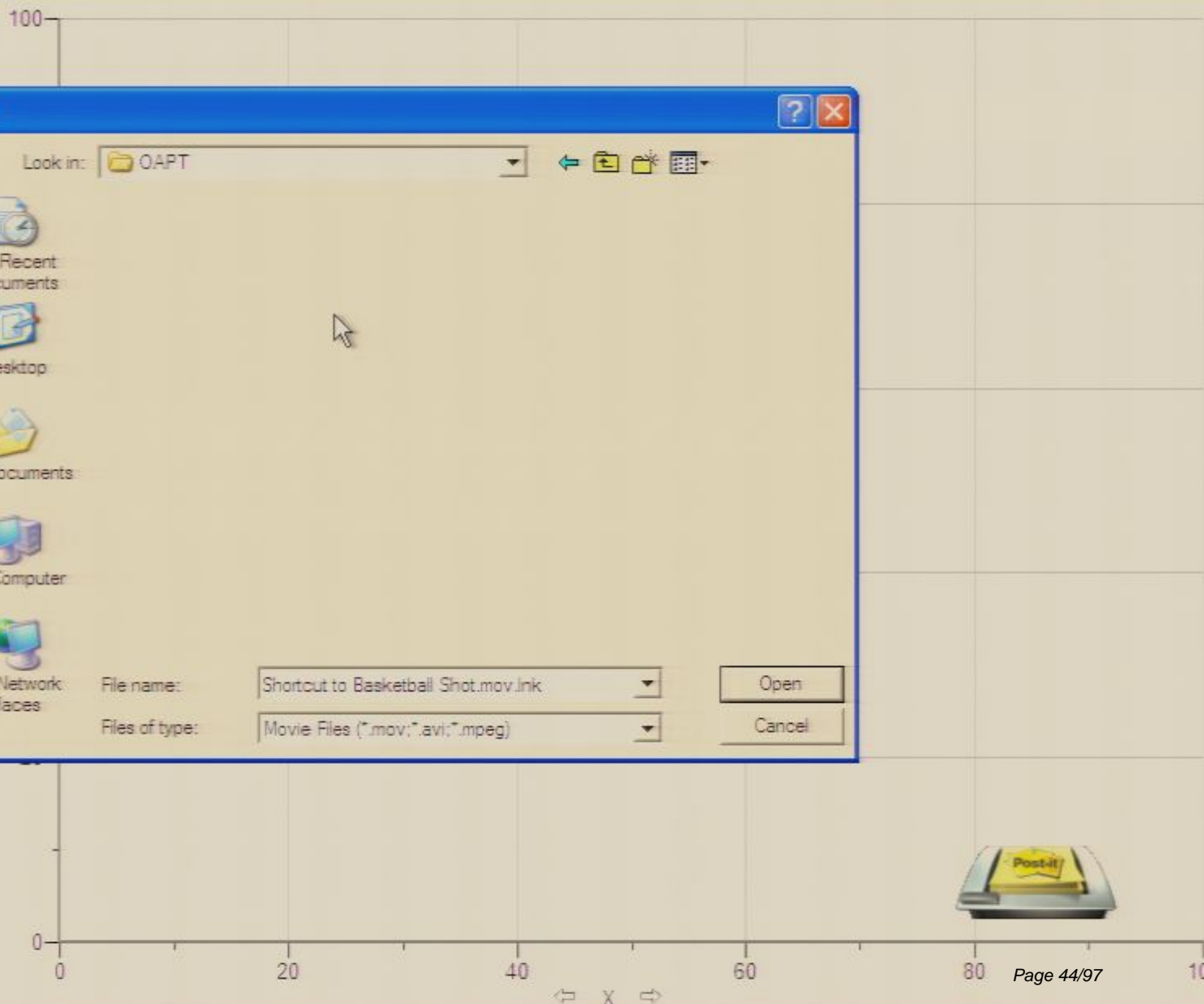
Look in: OAPT

- My Recent Documents
- Desktop
- My Documents
- My Computer
- My Network Places

File name: Shortcut to Basketball Shot.mov.link

Files of type: Movie Files (\*.mov;\*.avi;\*.mpeg)

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VideoAnalysis

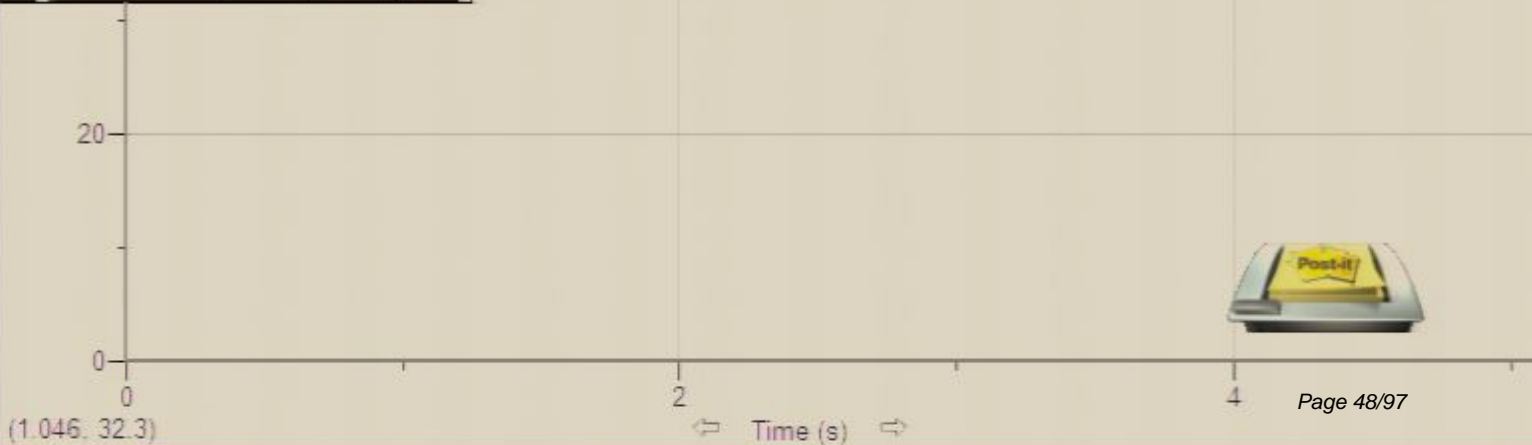
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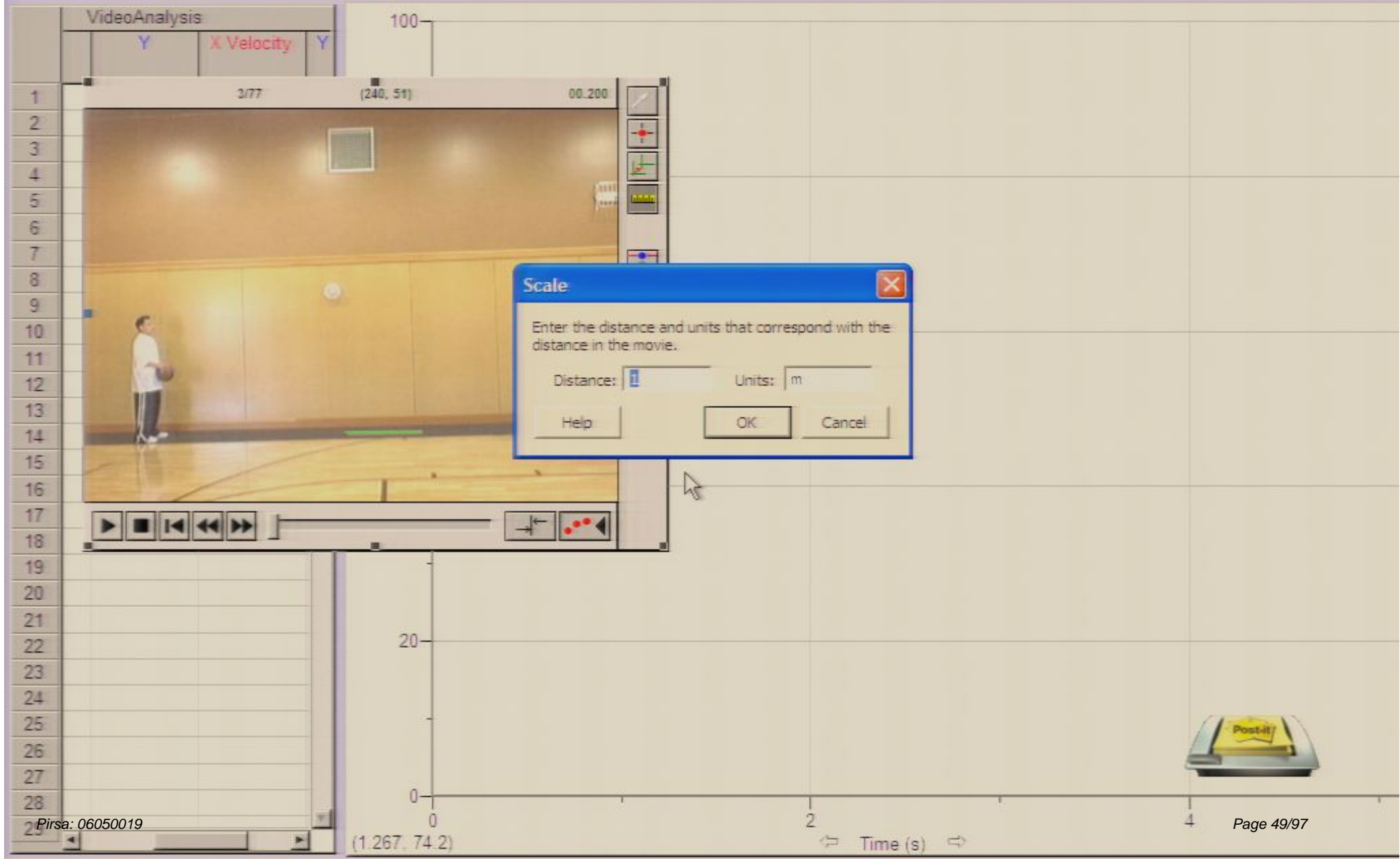
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**Scale**

Enter the distance and units that correspond with the distance in the movie.

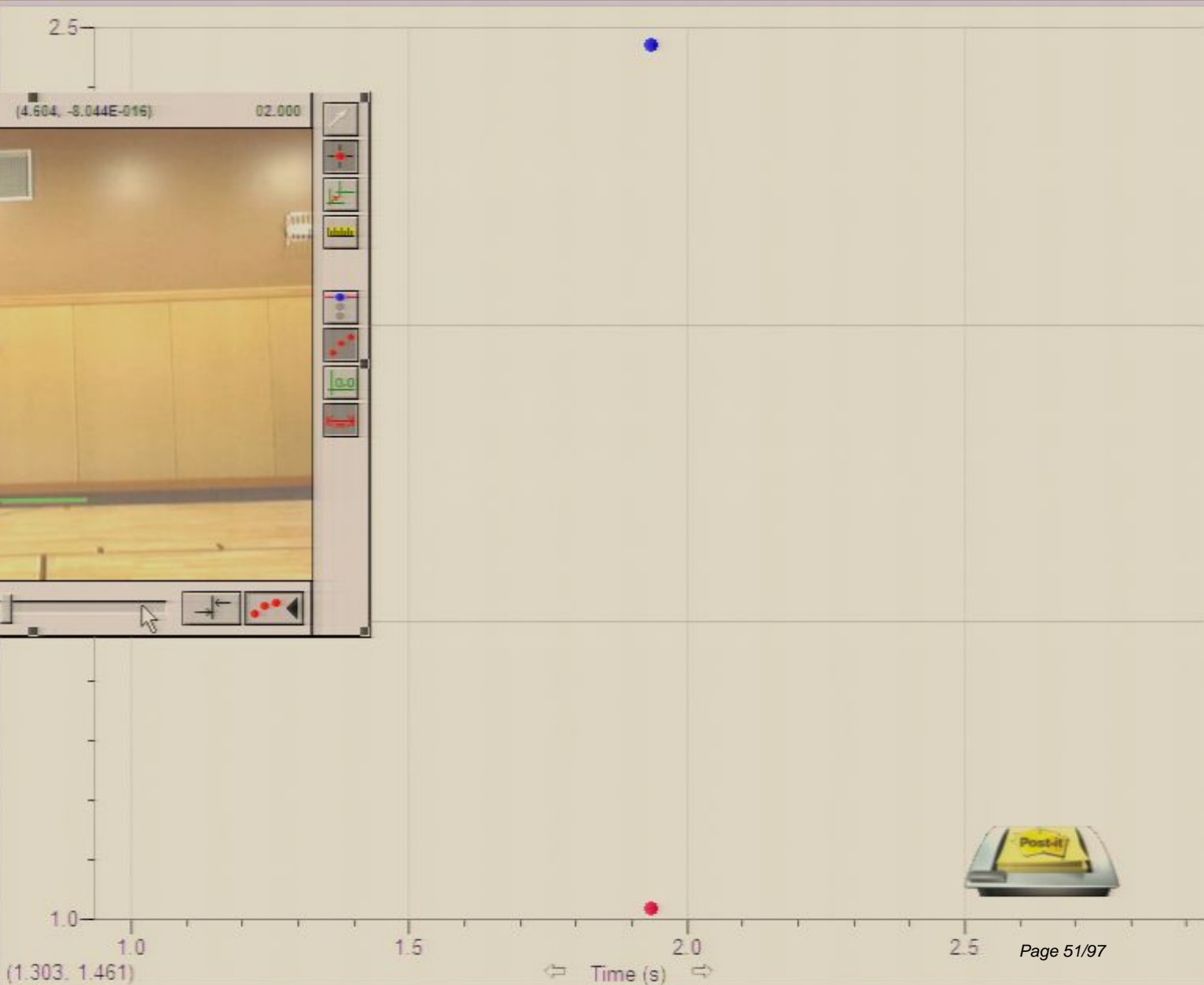
Distance:  Units:



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VideoAnalysis				
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VideoAnalysis

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[Video Player: Play, Stop, Previous, Next]

Pirsa: 06050019



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VideoAnalysis

	Y (m)	X Velocity (m/s)
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### Graph Options

Graph Options | Axes Options

Title:  black

Examine:

- Interpolate
- Mouse Position and Delta
- Legend

New Data:

- Add New Data Sets and Columns

Appearance:

- Point Protectors
- Connect Points
- Bar Graph
- Y Error Bars
- X Error Bars

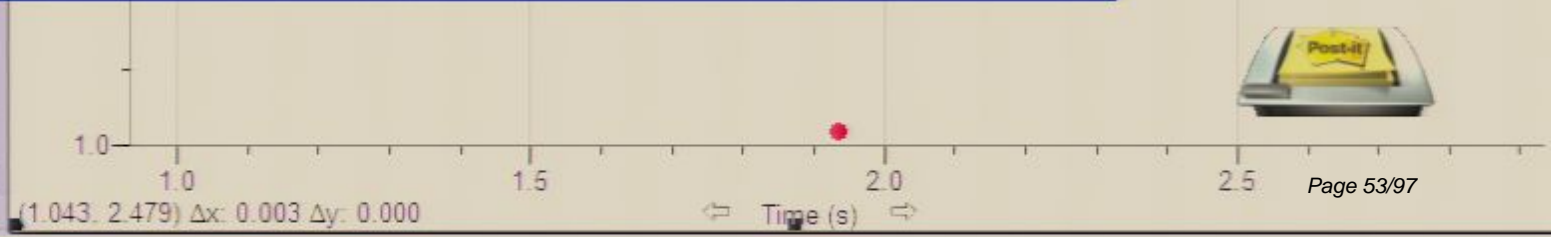
Note: Error bar calculations and Point Protector styles are set in the Column Options dialog for each column.

Grid:

Major Tick Style:  Solid   gray

Minor Tick Style:  No Line   gray

Buttons: Help Done Cancel



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VideoAnalysis

	Y (m)	X Velocity (m/s)
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### Graph Options

Graph Options: Axes Options

**Y-Axis:**

Label: \_\_\_\_\_

**Y-Axis Columns:**

- Time (s) \_\_\_\_\_
- X (m) \_\_\_\_\_
- Y (m) \_\_\_\_\_
- X Velocity (m/s) \_\_\_\_\_
- Y Velocity (m/s) \_\_\_\_\_

Scaling: Autoscale

Top: 2.5

Bottom: 1

**Right Y-Axis:**

Label: \_\_\_\_\_

**Right Y-Axis Columns:**

- Time (s) \_\_\_\_\_
- X (m) \_\_\_\_\_
- Y (m) \_\_\_\_\_
- X Velocity (m/s) \_\_\_\_\_
- Y Velocity (m/s) \_\_\_\_\_

Scaling: Autoscale

Top: 100

Bottom: 0

**X-Axis:**

Column: Time (s)

Scaling: Autoscale

Rotate Tick Labels: 0 Degrees

Make All Values Major Ticks

Left: 0.93333333 Right: 2.93333333

Help Done Cancel



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VideoAnalysis

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### Graph Options

Graph Options: Axes Options

**Y-Axis:**

Label: \_\_\_\_\_

**Y-Axis Columns:**

- Time (s) —
- X (m) —●
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- X Velocity (m/s) —▲
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Scaling: Autoscale

Top: 2.5

Bottom: 1

**Right Y-Axis:**

Label: \_\_\_\_\_

**Right Y-Axis Columns:**

- Time (s) —
- X (m) —●
- Y (m) —●
- X Velocity (m/s) —▲
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Scaling: Autoscale

Top: 100

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**X-Axis:**

Column: Time (s)

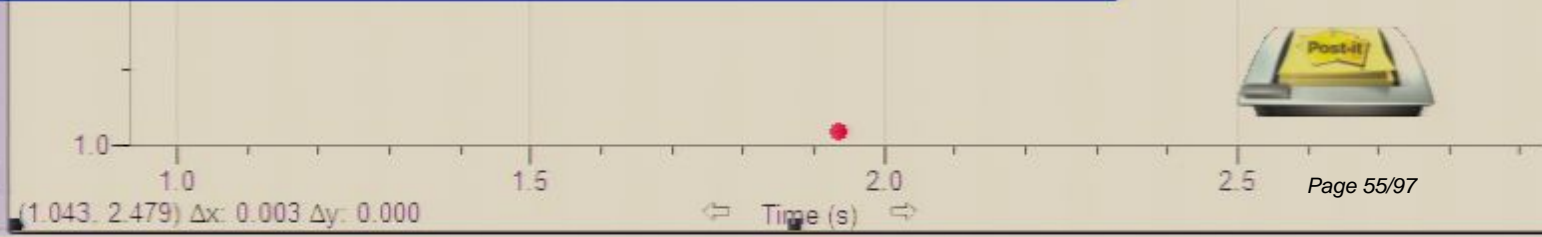
Rotate Tick:

Make A:

Scaling: Autoscale

Left: 0.9333333333 Right: 2.9333333333


Help Done Cancel



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VideoAnalysis

	Y (m)	X Velocity (m/s)
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17 [Play] [Stop] [Previous] [Next]

### Graph Options

Graph Options | Axes Options

**Y-Axis:**

Label: \_\_\_\_\_

**Y-Axis Columns:**

- Time (s) \_\_\_\_\_
- X (m) \_\_\_\_\_
- Y (m) \_\_\_\_\_
- X Velocity (m/s) \_\_\_\_\_
- Y Velocity (m/s) \_\_\_\_\_

Scaling: Autoscale

Top: 2.5

Bottom: 1

**Right Y-Axis:**

Label: \_\_\_\_\_

**Right Y-Axis Columns:**

- Time (s) \_\_\_\_\_
- X (m) \_\_\_\_\_
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- X Velocity (m/s) \_\_\_\_\_
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Scaling: Autoscale

Top: 100

Bottom: 0

**X-Axis:**

Column: Time (s)

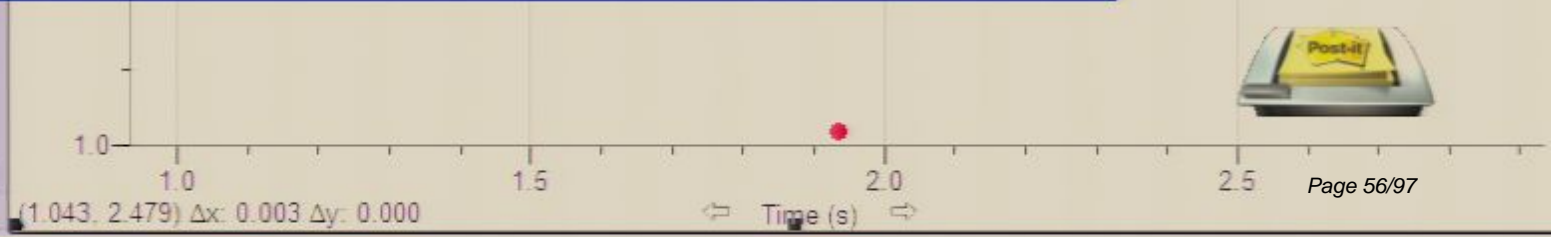
Scaling: Autoscale

Rotate Tick Labels: 0 Degrees

Left: 0.9333333333 Right: 2.9333333333

Make All Values Major Ticks

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### Graph Options

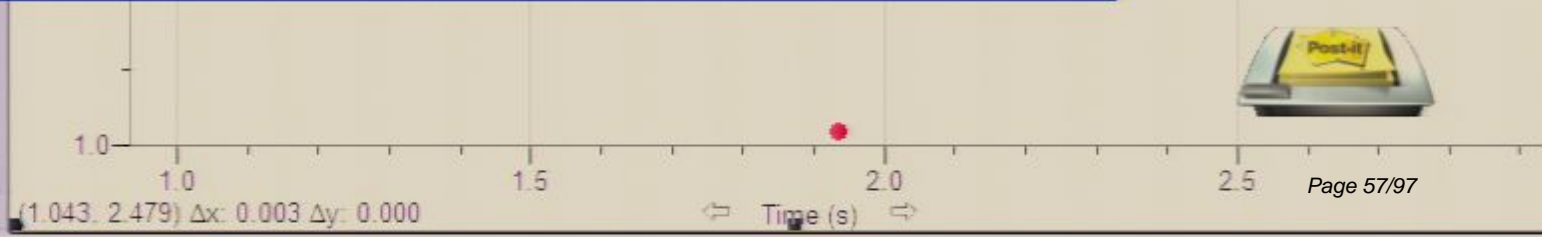
Graph Options: Axes Options

**Y-Axis:**  
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Y-Axis Columns:  
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 Y (m) \_\_\_\_\_  
 X Velocity (m/s) \_\_\_\_\_  
 Y Velocity (m/s) \_\_\_\_\_  
Scaling: Autoscale  
Top: 2.5  
Bottom: 1

**Right Y-Axis:**  
Label: \_\_\_\_\_  
Right Y-Axis Columns:  
 Time (s) \_\_\_\_\_  
 X (m) \_\_\_\_\_  
 Y (m) \_\_\_\_\_  
 X Velocity (m/s) \_\_\_\_\_  
 Y Velocity (m/s) \_\_\_\_\_  
Scaling: Autoscale  
Top: 100  
Bottom: 0

**X-Axis:**  
Column: Time (s) \_\_\_\_\_  
Scaling: Autoscale  
Rotate Tick Labels: 0 Degrees  
Left: 0.9333333333 Right: 2.9333333333  
 Make All Values Major Ticks

Help Done Cancel



No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y
1	01	30/77	
2			
3			
4			
5			
6			
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Y (m)

Time (s)

Pirsa: 06050019



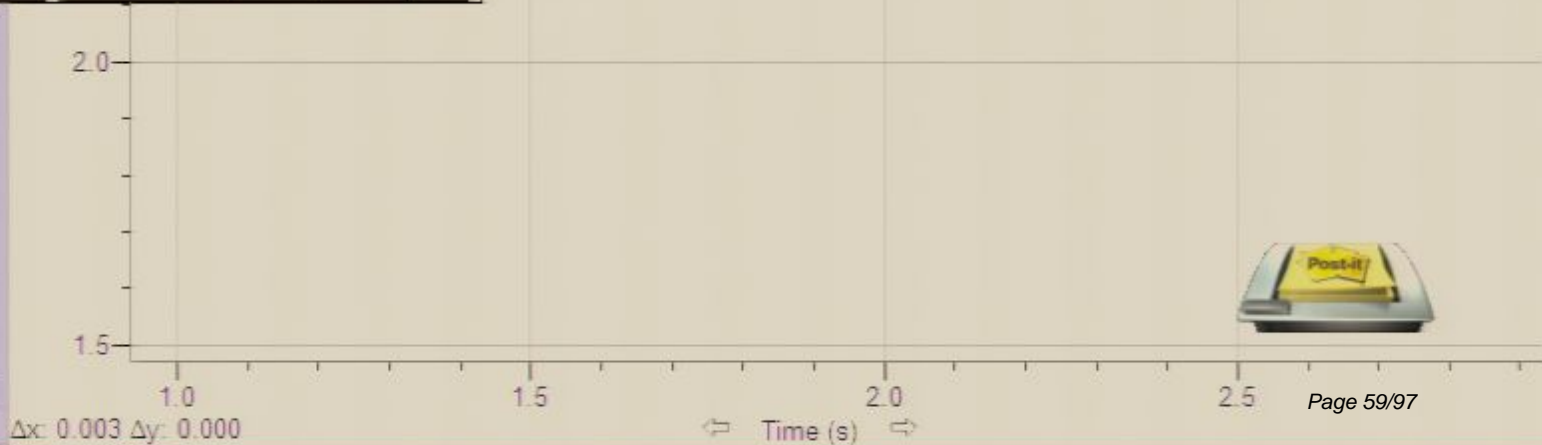
No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	30/77	(1.698, 3.000)	02.000

01 30/77 (1.698, 3.000) 02.000

Video analysis window showing a person in a gym. A crosshair is overlaid on the video frame. A blue dot is visible on the video frame. The window includes a timeline and playback controls.

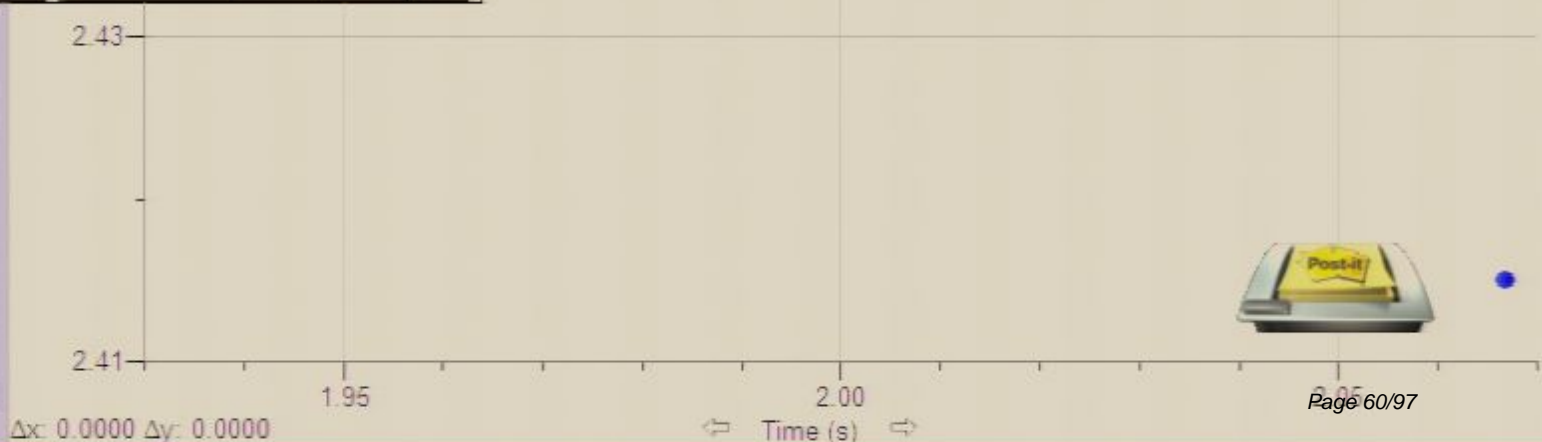


No device connected.

VideoAnalysis				
	Y (m)	X Velocity (m/s)	Y	
1	01	32/77	(3.000, 0.1132)	02.133
2	24			
3				
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5				
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Video analysis window showing a person in a gymnasium. The window includes a video frame, playback controls (play, stop, previous, next, seek), and a coordinate readout: (3.000, 0.1132). The video frame shows a person in a white shirt and dark pants, holding a blue ball, standing on a wooden floor in a gymnasium with wood-paneled walls.

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No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	24/77	(0.9404, 2.604)	02.266
2	24			
3	43			
4				
5				
6				
7				
8				
9				
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18				



01 24/77 (0.9404, 2.604) 02.266

24 43

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Pirsa: 06050019

	Y (m)	X Velocity (m/s)	Y
19			
20			
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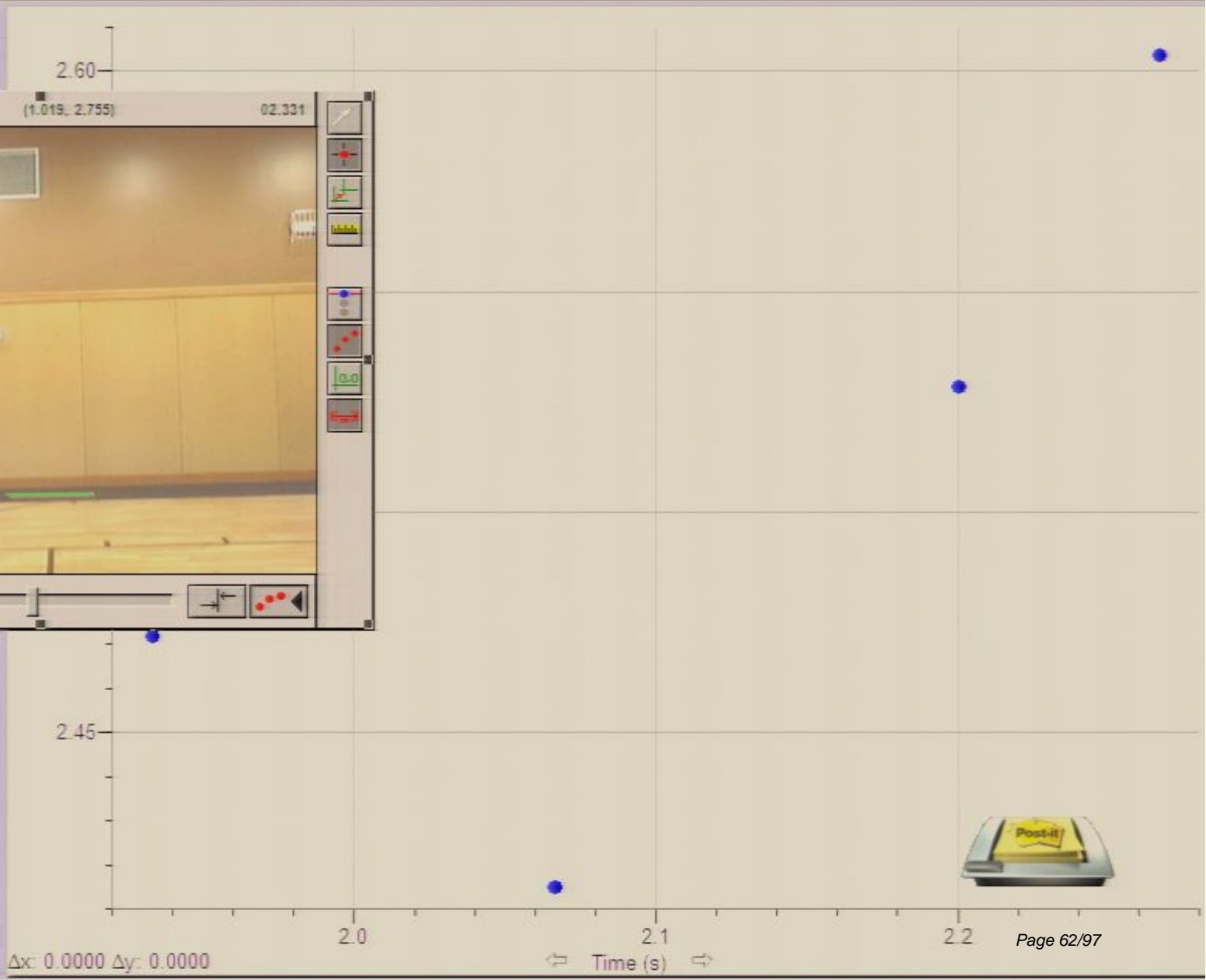
No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	35/77	(1.019, 2.755)	02.331
2	24			
3	43			
4	43			
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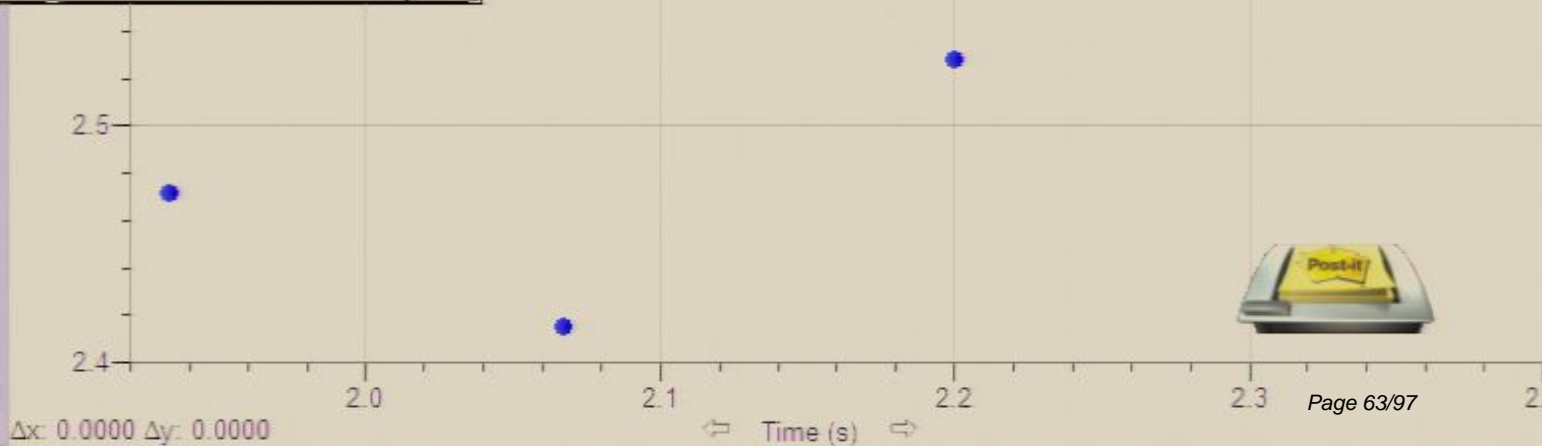
No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	37/77	(1.283, 3.151)	02.465
2	24			
3	43			
4	43			
5	01			
6	11			
7				
8				
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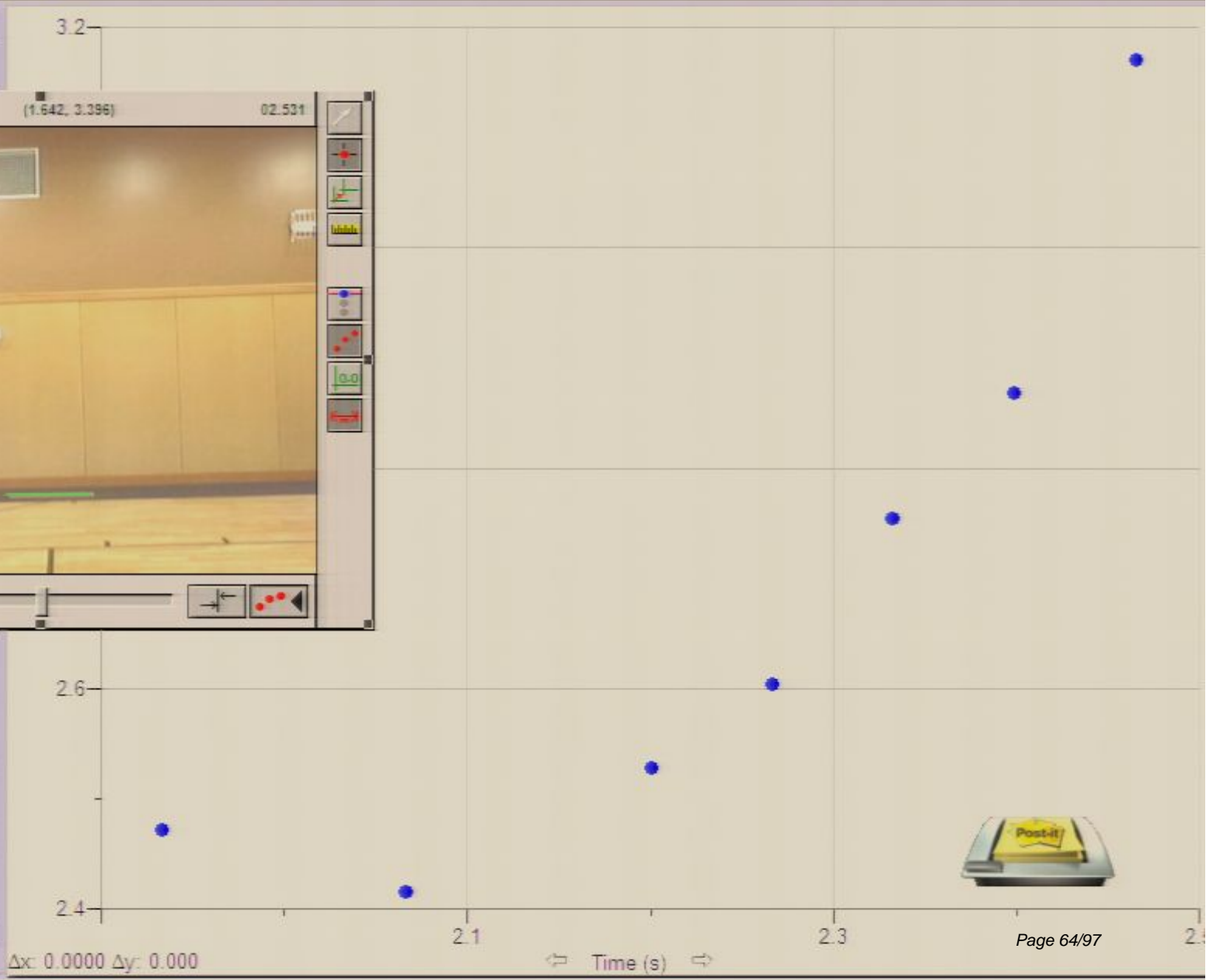

02.465



No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	38/77	(1.642, 3.396)	02.531
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
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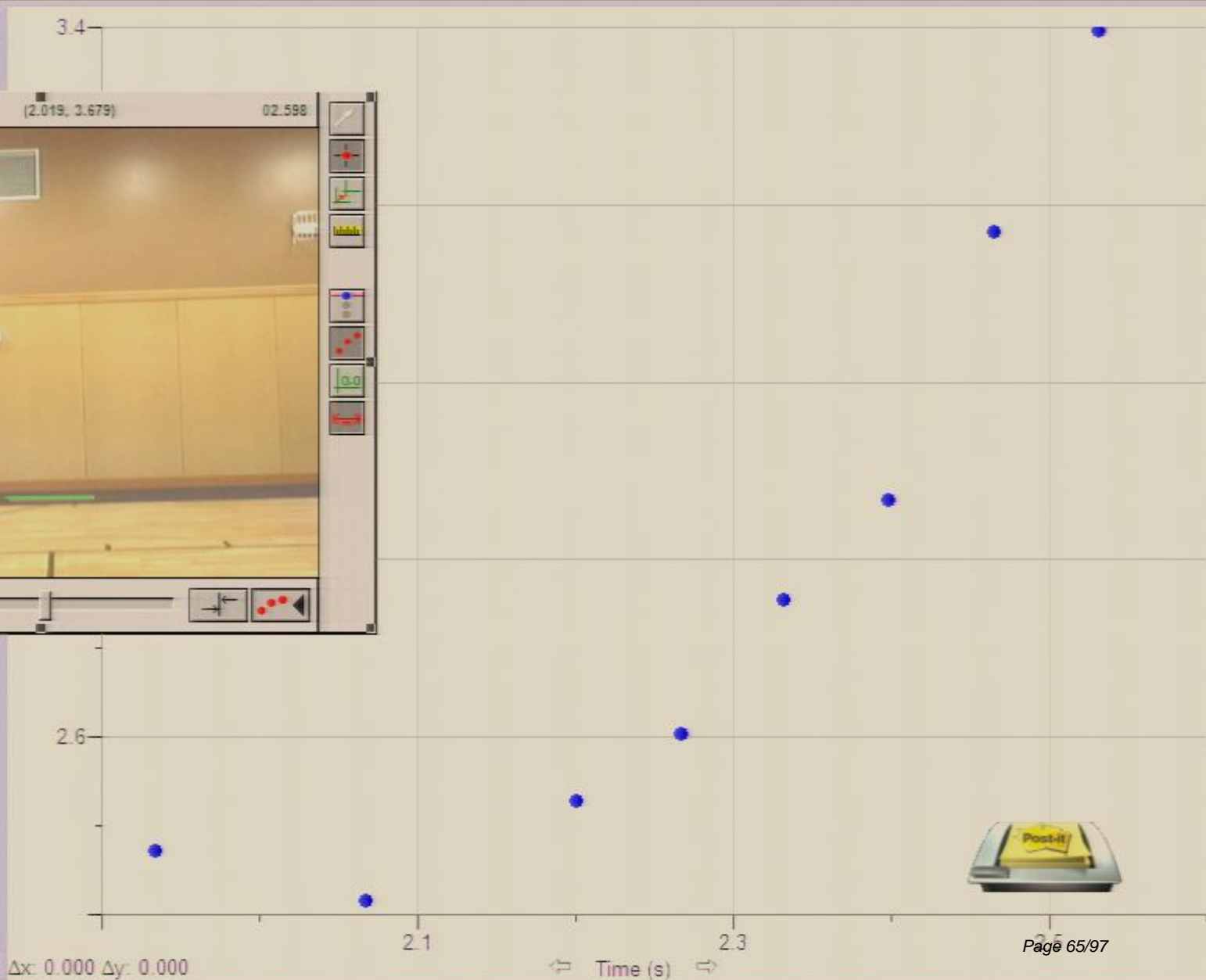
No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	39/77	(2.019, 3.679)	02.598
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
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39/77 (2.019, 3.679) 02.598

Video analysis window showing a person shooting a basketball. The video frame includes a trajectory overlay of blue dots and a crosshair. The window has a timeline at the bottom with play, stop, and other controls.

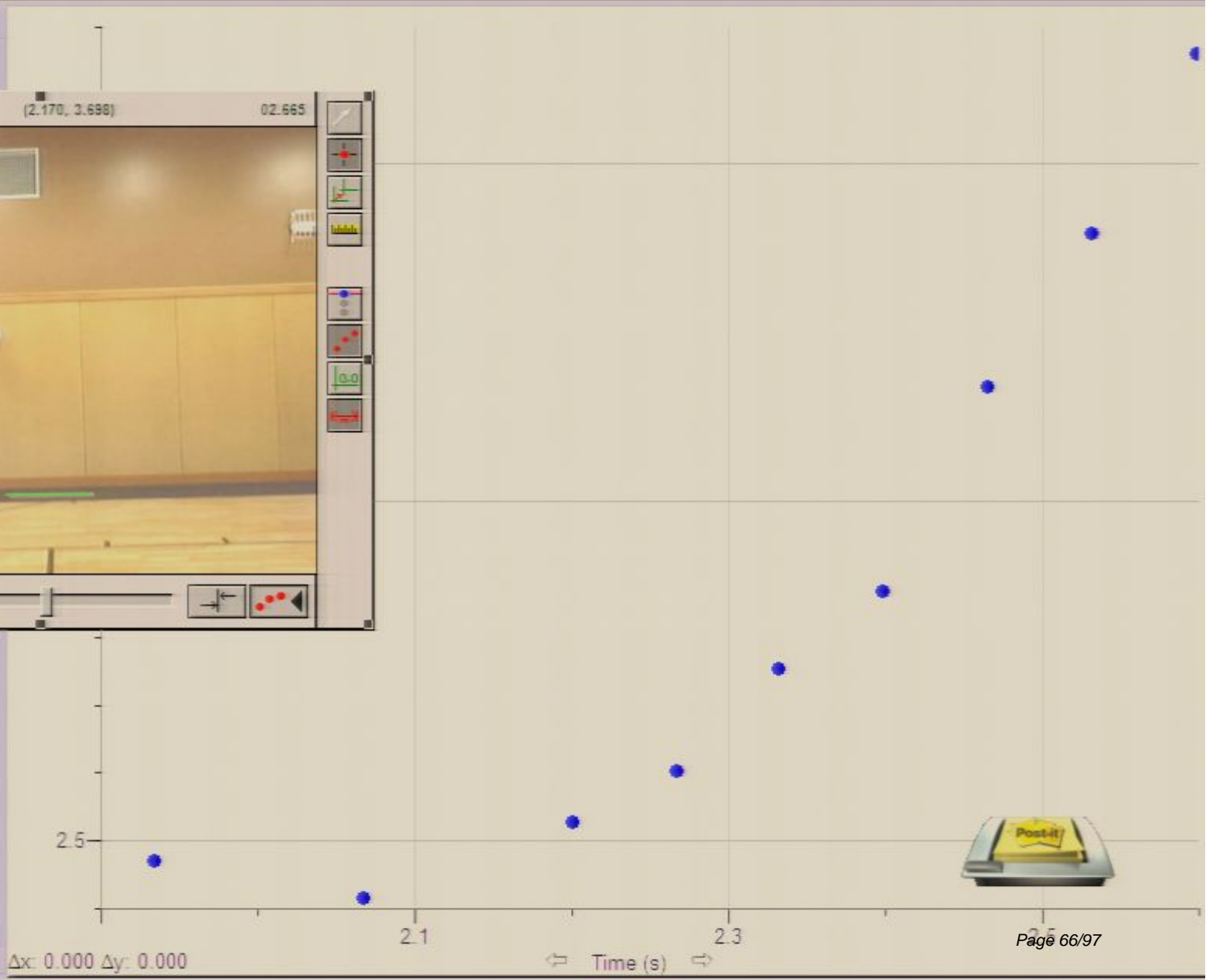


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	40/77	(2.170, 3.698)	02.665
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
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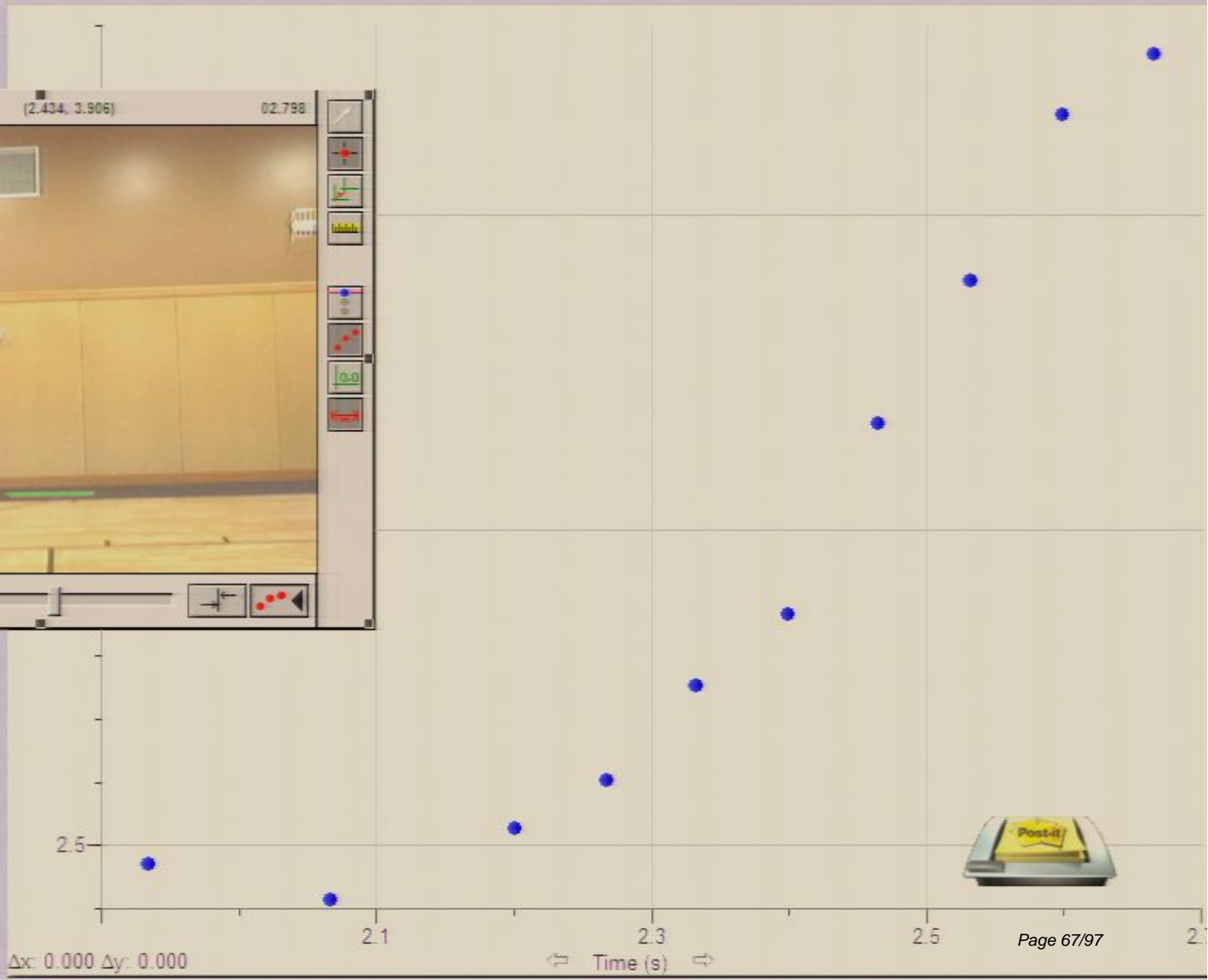
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No device connected.

VideoAnalysis

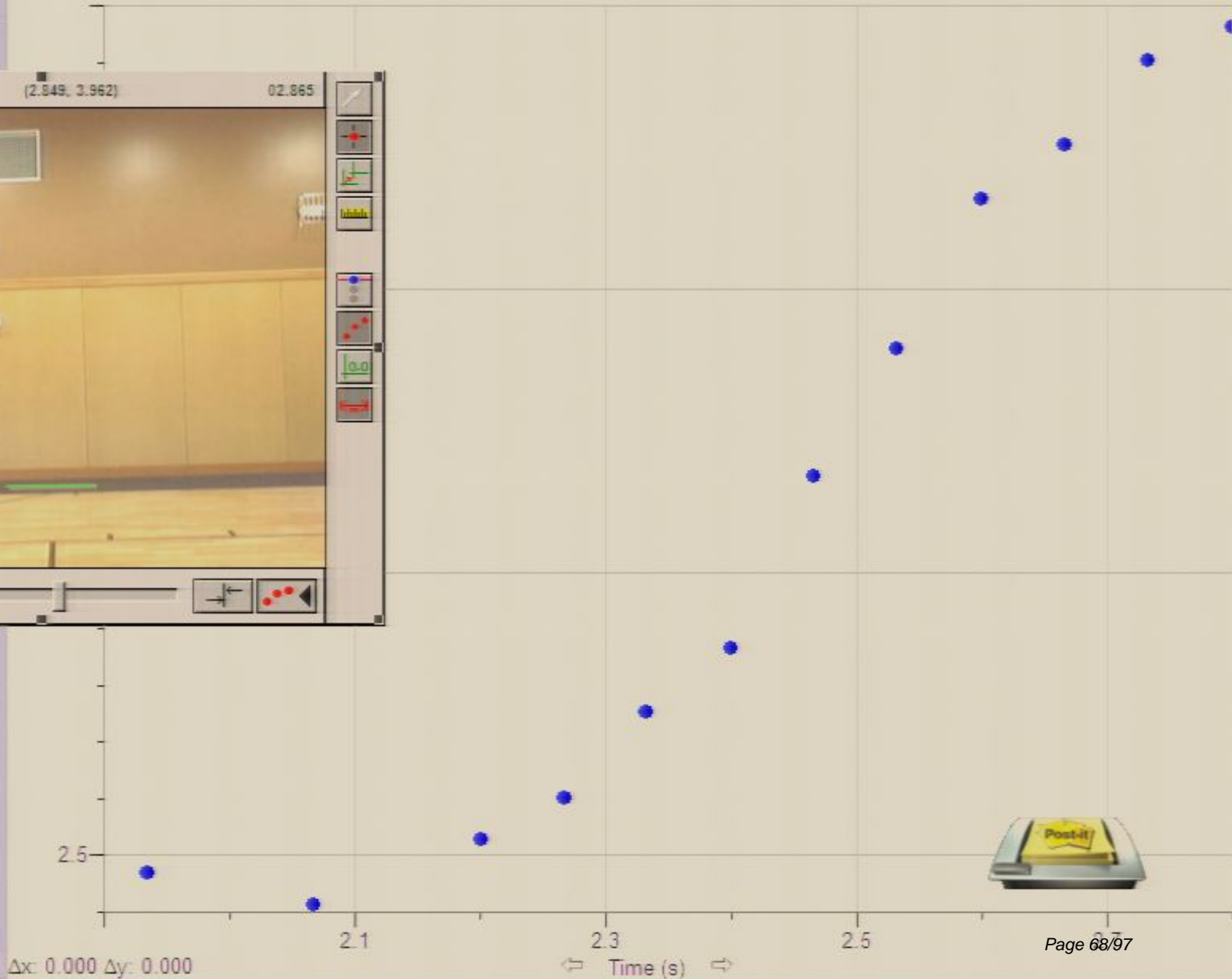
	Y (m)	X Velocity (m/s)	Y	
1	01	42/77	(2.434, 3.906)	02.798
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
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No device connected.

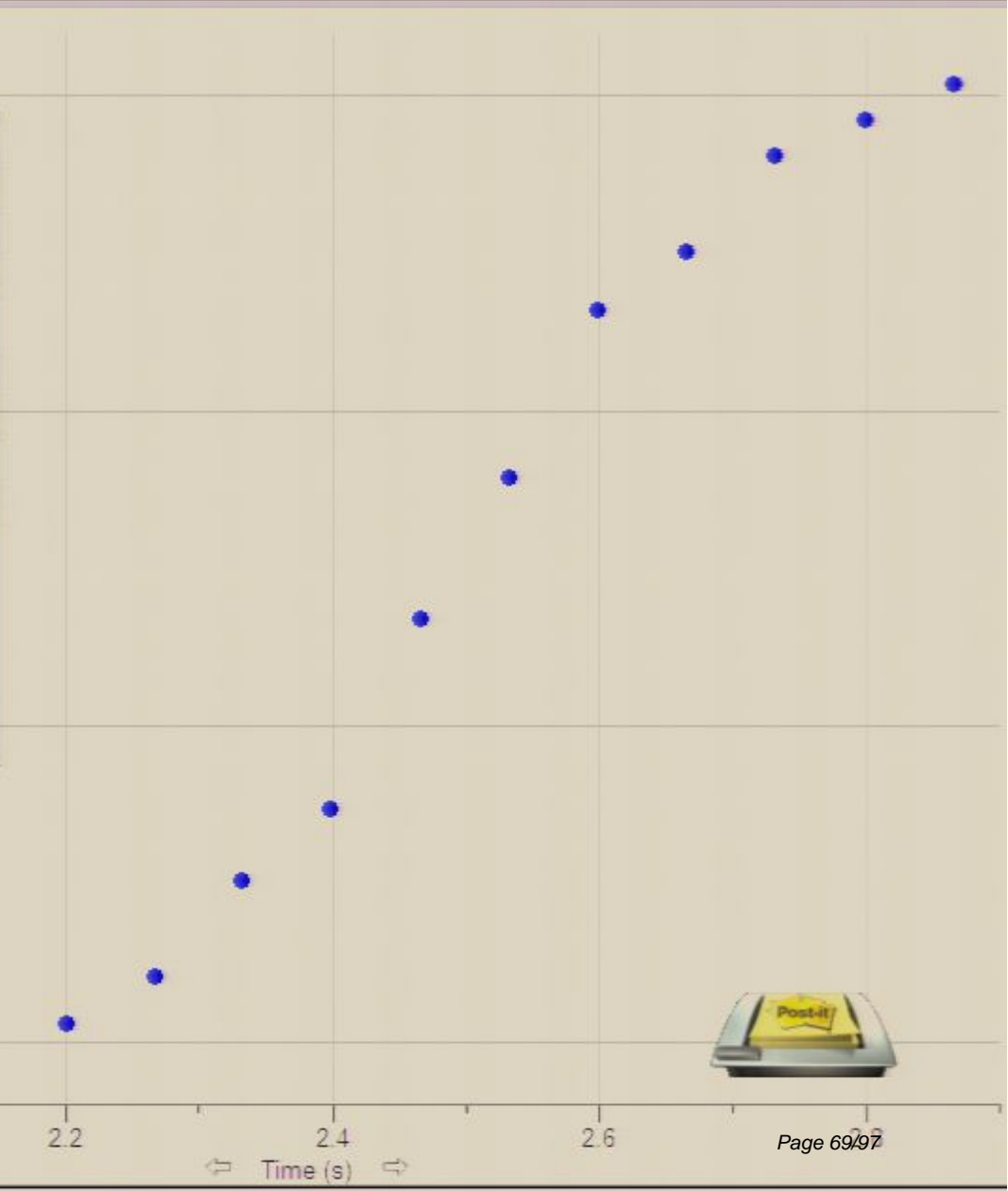
VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	43/77	(2.848, 3.962)	02.865
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
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No device connected.

VideoAnalysis				
	Y (m)	X Velocity (m/s)	Y	
1	01	44/77	(3.377, 3.943)	02.931
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
12	71			
13	96			
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No device connected.

VideoAnalysis			
	Y (m)	X Velocity (m/s)	Y
1	01	46/77	03.065
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
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4.0  
(3.491, 3.943)



No device connected.

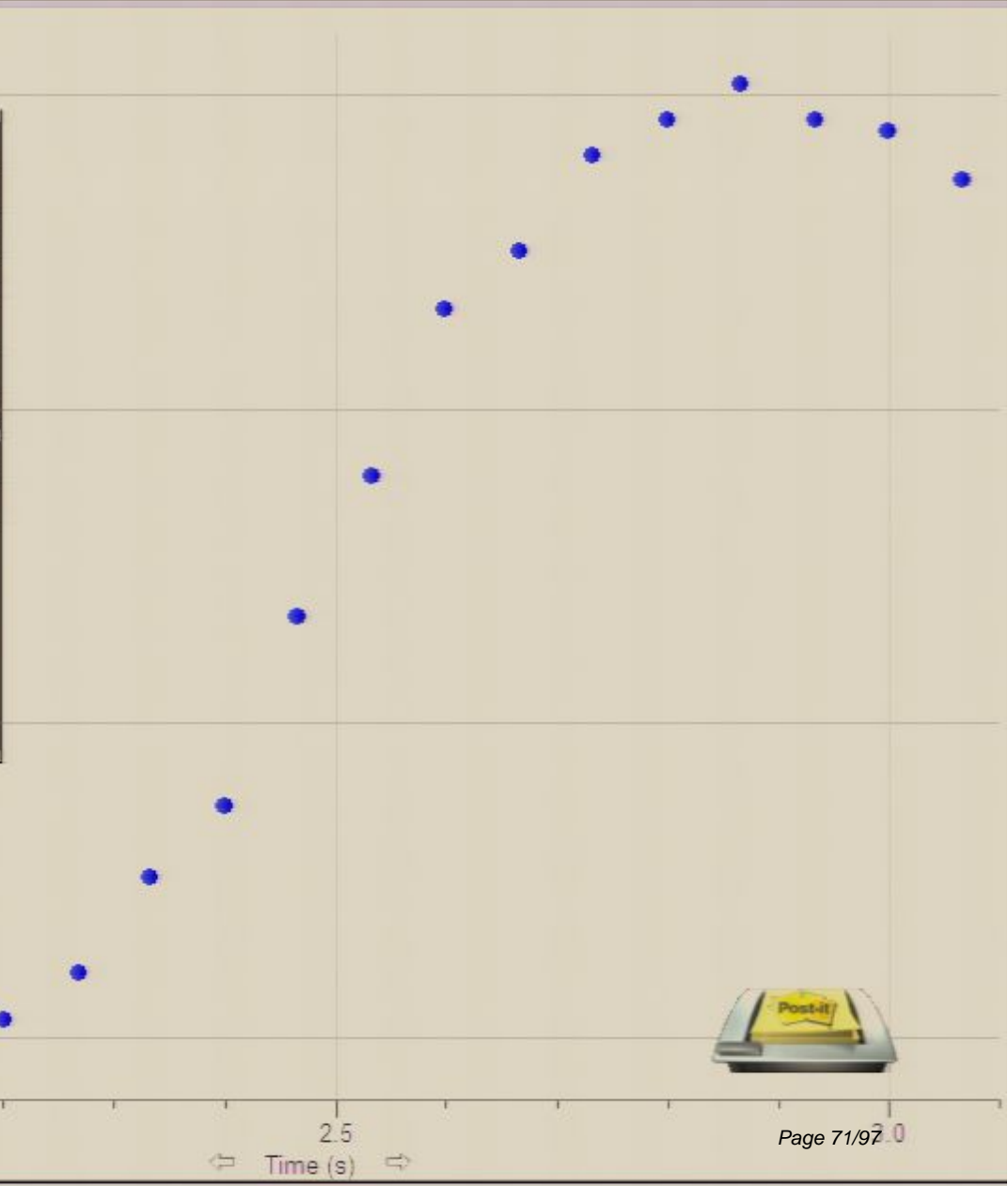
VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	47/77	(4.113, 3.679)	03.131
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
12	71			
13	96			
14	28			
15	49			
16	77			

4.0

(4.113, 3.679)

03.131



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No device connected.

VideoAnalysis				
	Y (m)	X Velocity (m/s)	Y	
1	01	48/77	(4.264, 3.528)	03.198
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
12	71			
13	96			
14	28			
15	49			
16	77			
17	11			





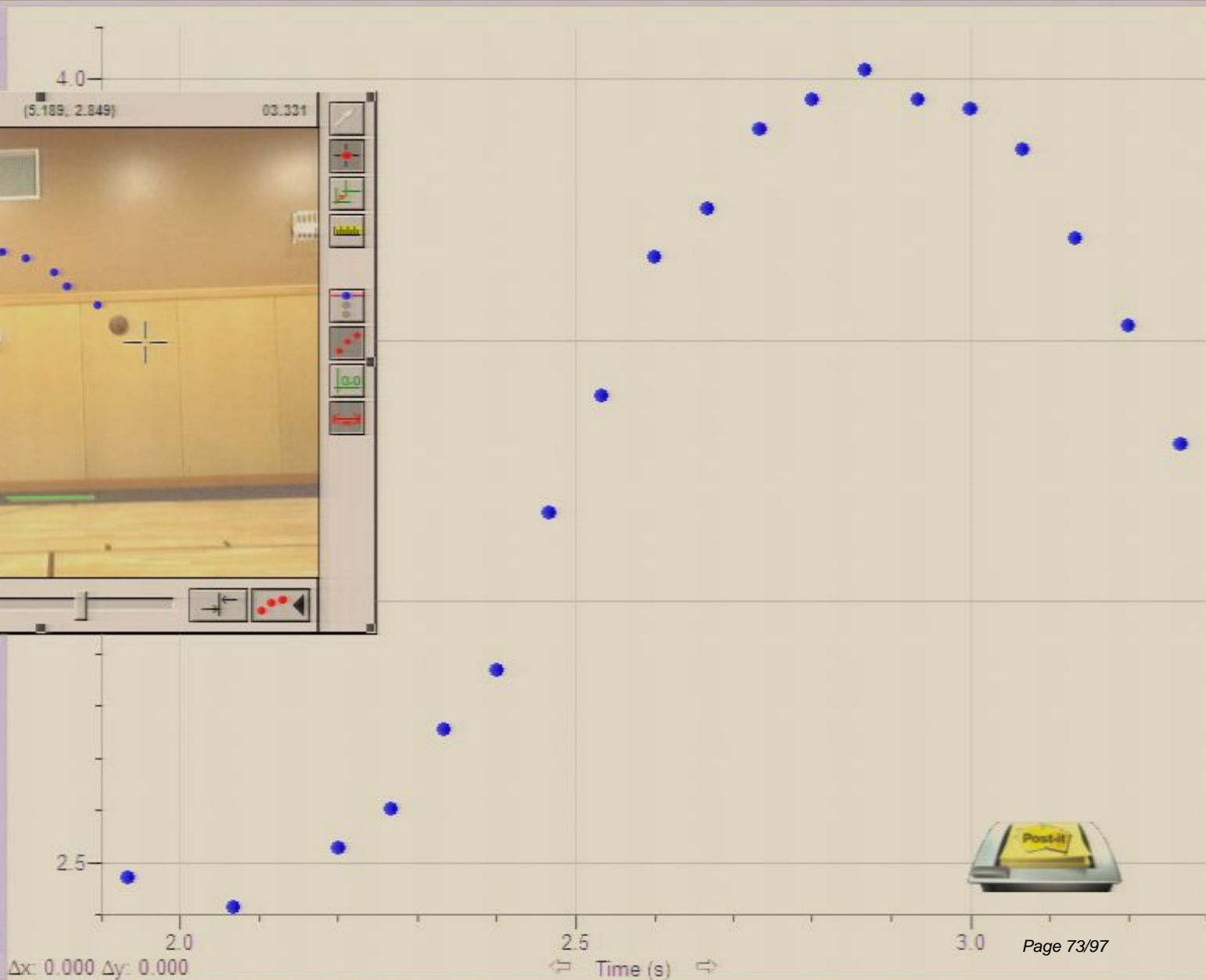
No device connected.

VideoAnalysis

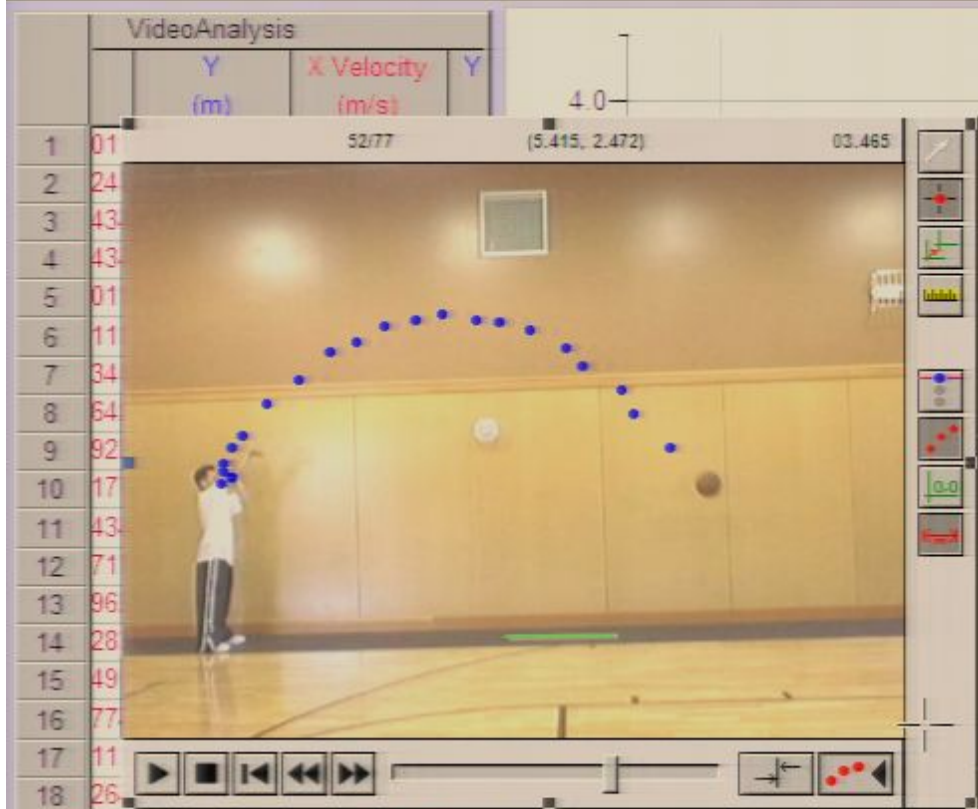
	Y (m)	X Velocity (m/s)	Y	
1	01	50/77	(5.189, 2.849)	03.331
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
12	71			
13	96			
14	28			
15	49			
16	77			
17	11			
18	26			

50/77 (5.189, 2.849) 03.331

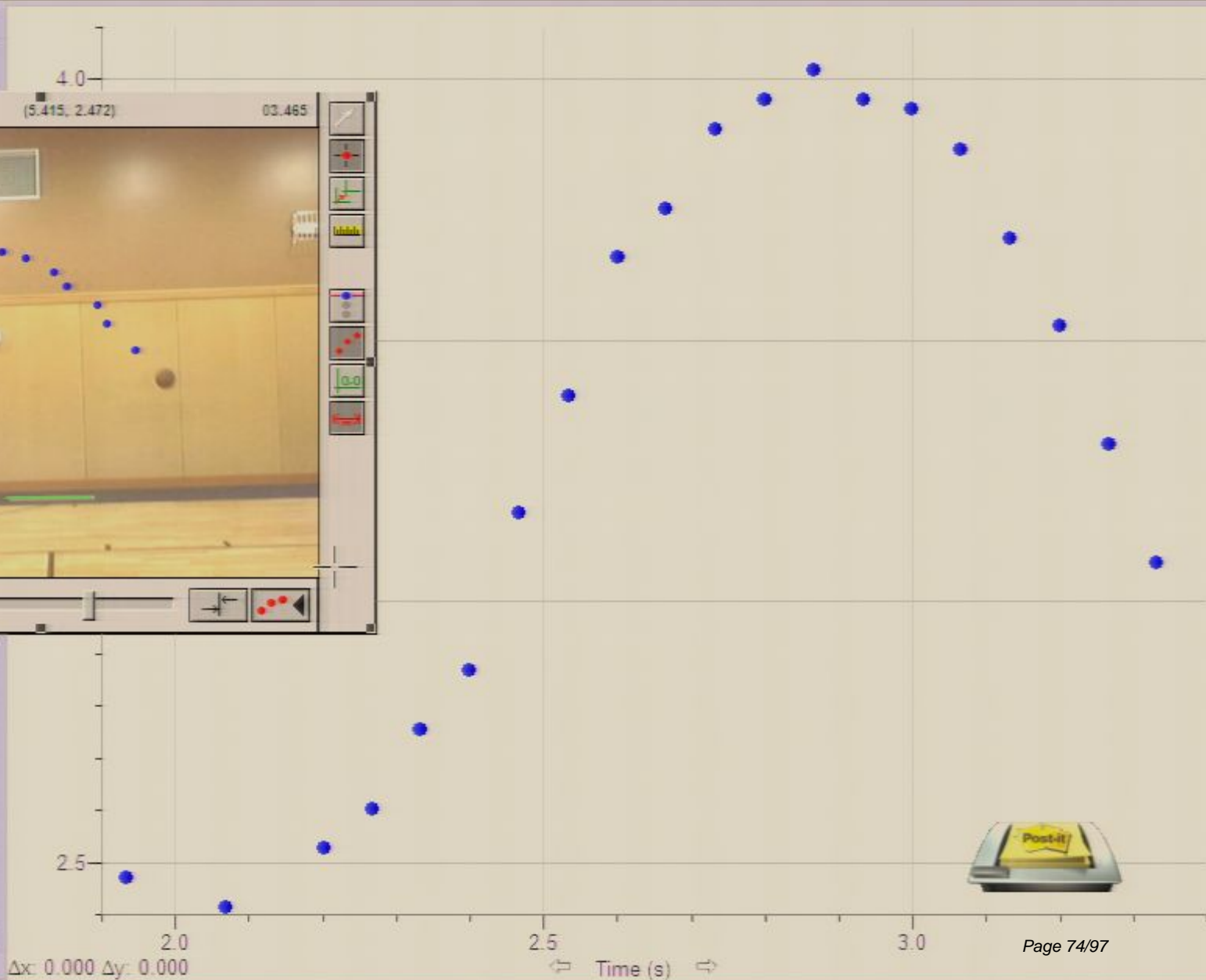
19	623	3.302	4.670
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No device connected.



19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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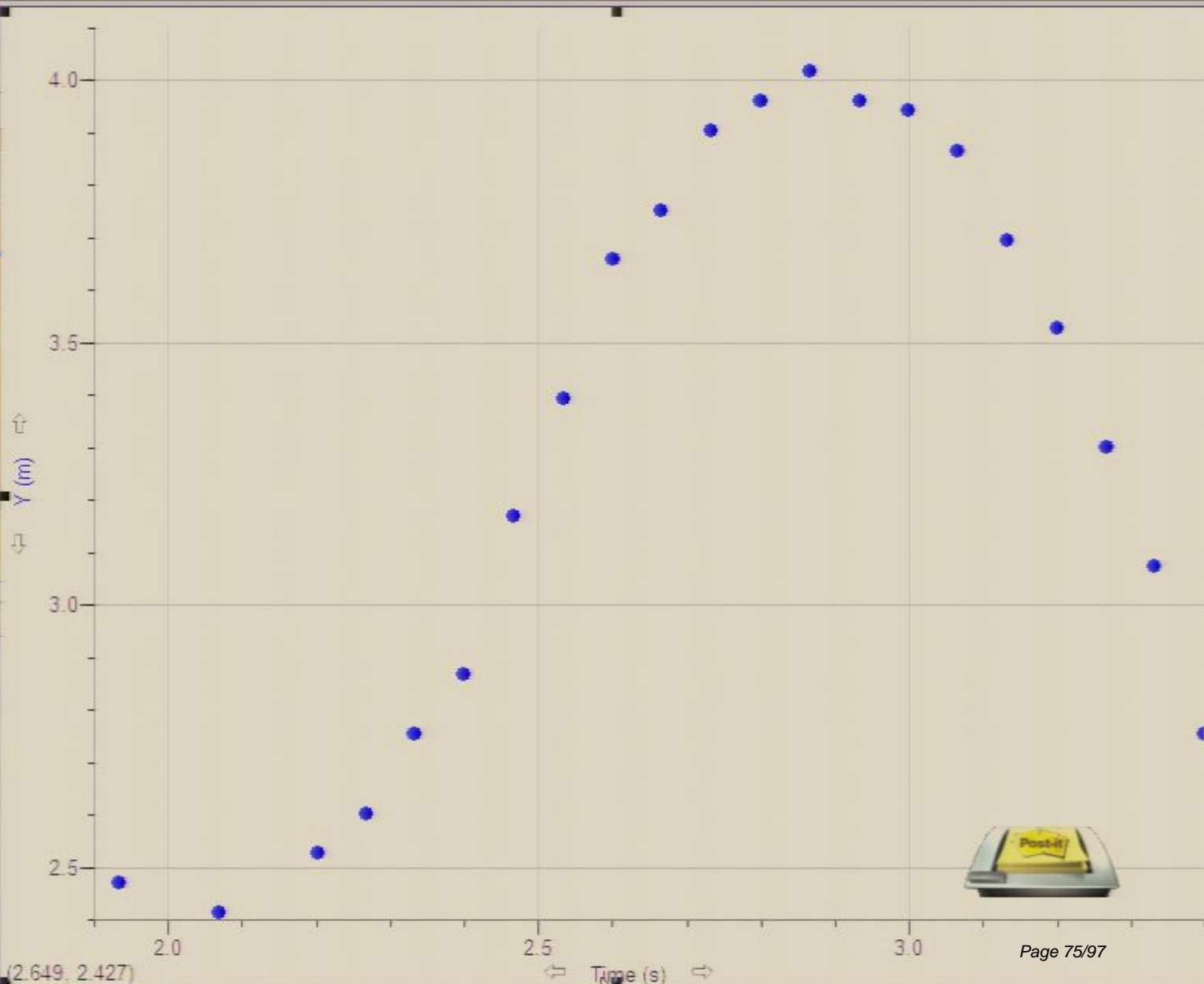


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y
1	01	52/77	
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
16	77		
17	11		
18	26		
19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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Pirsa: 06050019

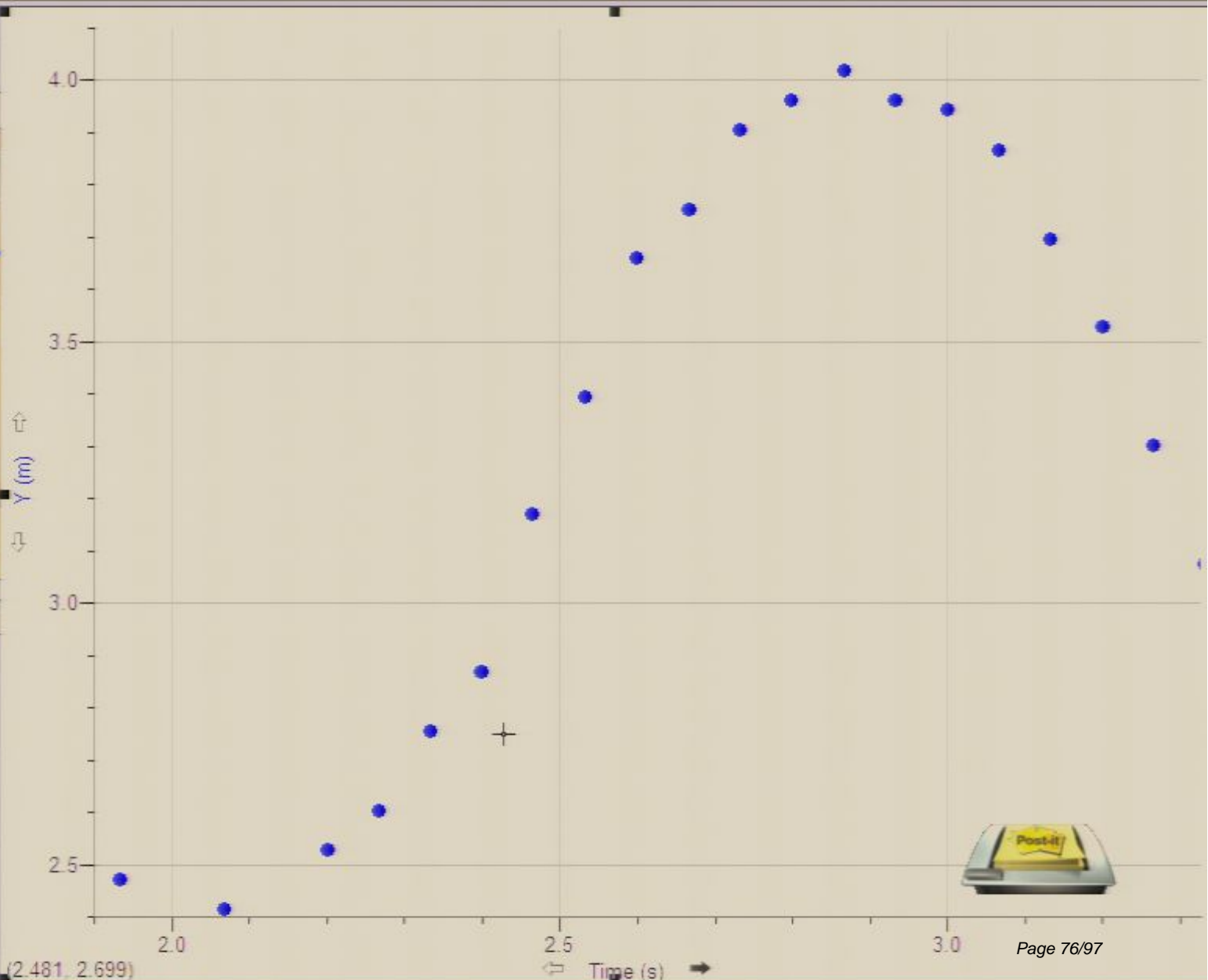


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y
1	01	52/77	
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
16	77		
17	11		
18	26		
19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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Pirsa: 06050019

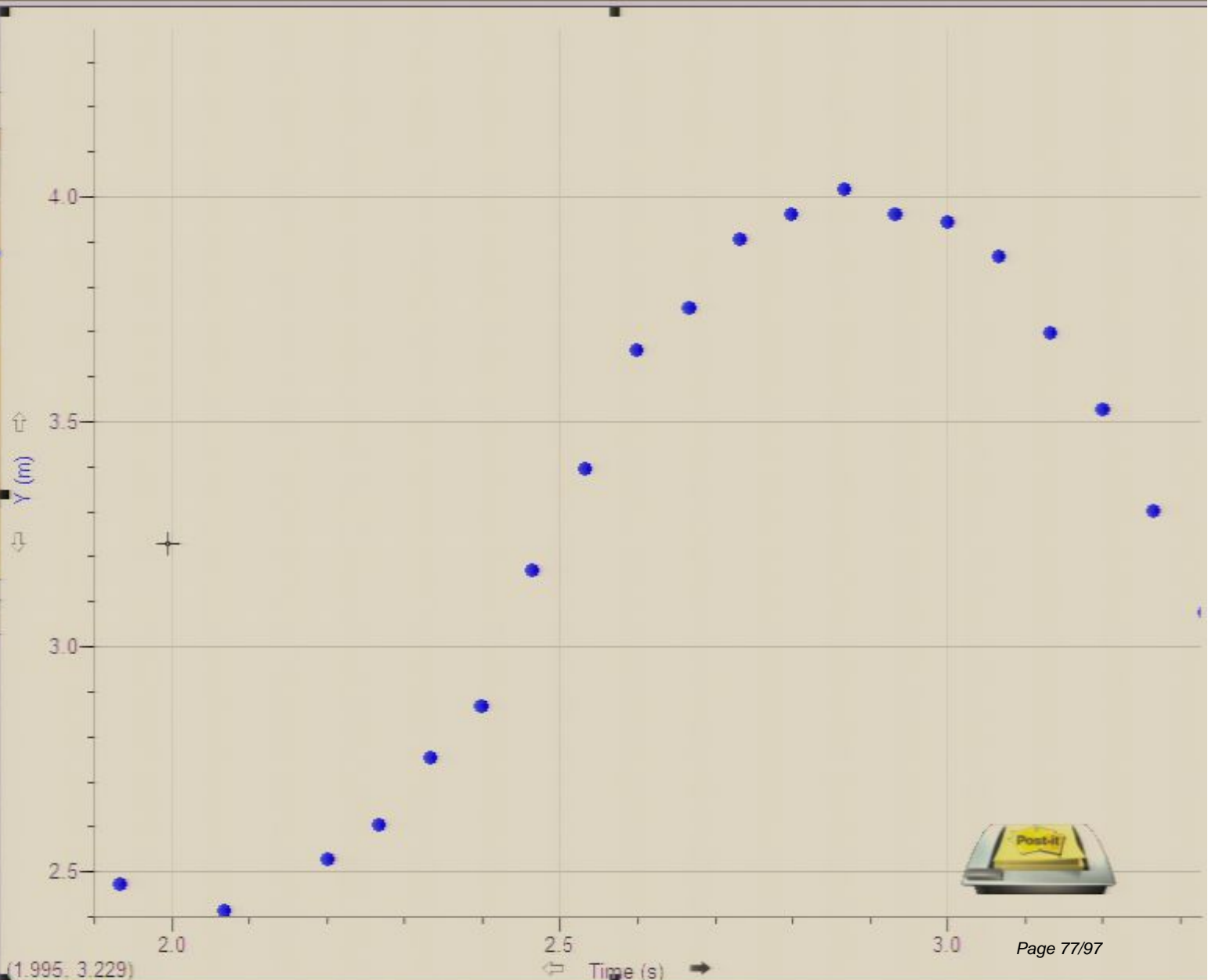


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y
1	01		52/77
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
16	77		
17	11		
18	26		
19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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Pirsa: 06050019



No device connected.

VideoAnalysis			
	Y (m)	X Velocity (m/s)	
1	01		52/77
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
16	77		
17	11		
18	26		
19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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### Graph Options

Graph Options: Axes Options

**Y-Axis:**

Label: \_\_\_\_\_

**Y-Axis Columns:**

- VideoAnalysis
- Time (s) —
- X (m) —●
- Y (m) —●
- X Velocity (m/s) —▲
- Y Velocity (m/s) —◆

Scaling: Autoscale

Top: 4.37467248908

Bottom: 2.4

**Right Y-Axis:**

Label: \_\_\_\_\_

**Right Y-Axis Columns:**

- VideoAnalysis
- Time (s) —
- X (m) —●
- Y (m) —●
- X Velocity (m/s) —▲
- Y Velocity (m/s) —◆

Scaling: Autoscale

Top: 100

Bottom: 0

**X-Axis:**

Column: Time (s)

Scaling: Autoscale

Rotate Tick Labels: 0 Degrees

Make All Values Major Ticks

Left: 1.9 Right: 3.326605504

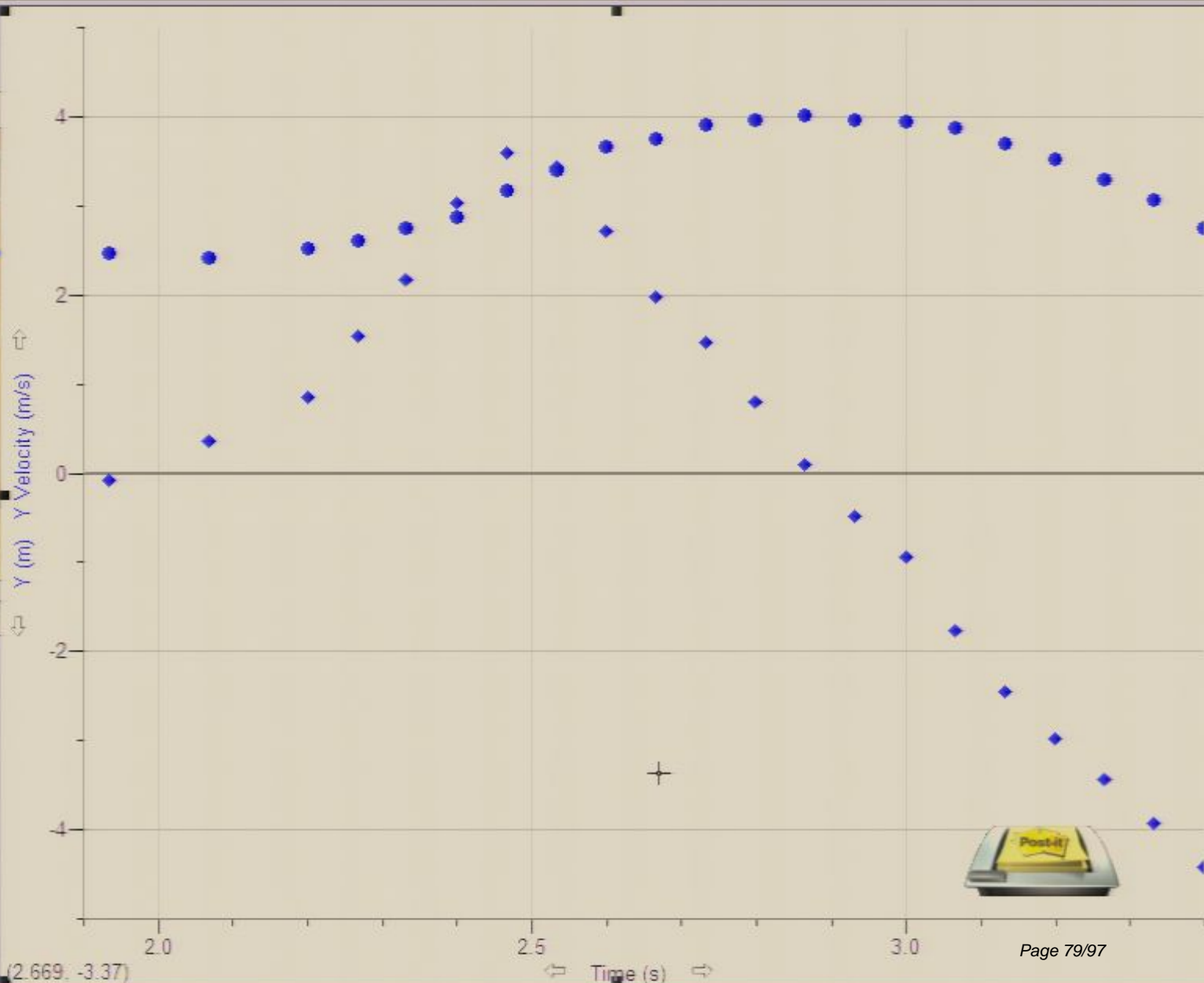


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y
1	01	52/77	
2	24		
3	43		
4	43		
5	01		
6	11		
7	34		
8	64		
9	92		
10	17		
11	43		
12	71		
13	96		
14	28		
15	49		
16	77		
17	11		
18	26		
19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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Pirsa: 06050019

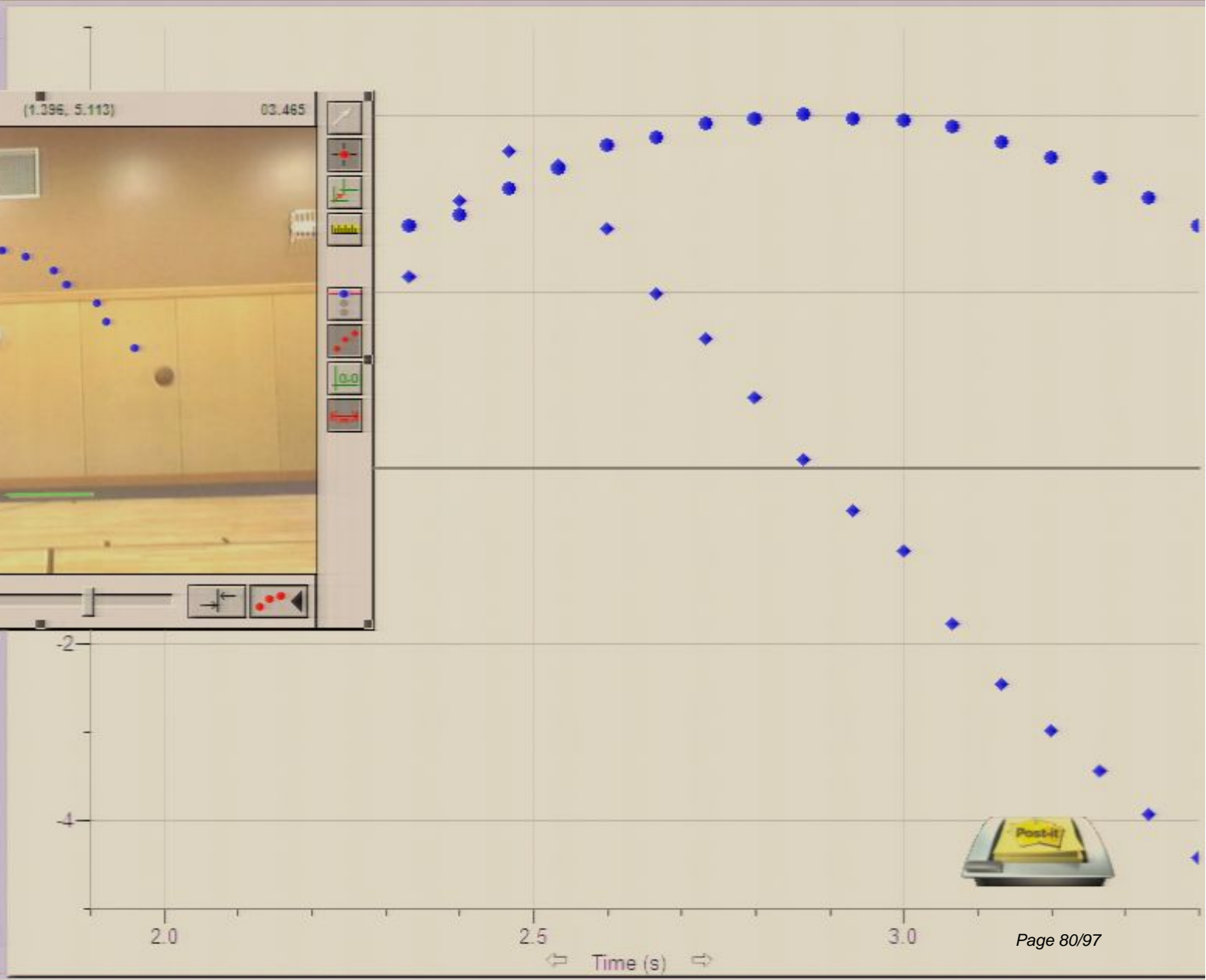


No device connected.

VideoAnalysis

	Y (m)	X Velocity (m/s)	Y	
1	01	52/77	(1.396, 5.113)	03.465
2	24			
3	43			
4	43			
5	01			
6	11			
7	34			
8	64			
9	92			
10	17			
11	43			
12	71			
13	96			
14	28			
15	49			
16	77			
17	11			
18	26			

19	623	3.302	3.623
20	736	3.075	3.652
21	075	2.755	4.355
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Outline Slides

- 14 Circular motion
- 15 Circular motion
- 16 Collision (Elastic or Inelastic)
- 17 Understanding acceleration
- 18 Understanding acceleration using a Graph
- 19 A diagrammatic Using Web Camera

# Circular Motion

- More accurate data for time
- Response time reduced
- More precise data for number of revolutions as points are plotted on the video
- More precise time period measured



May 27, 2006

14

Click to add notes



14 Characteristic of motion

15 Characteristic of motion

16 Collision (Elastic or Inelastic)

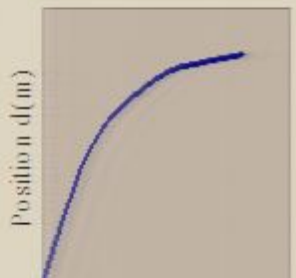
17 Understanding acceleration

18 Understanding acceleration using a Graph

19 Advantages of Using Web Camera

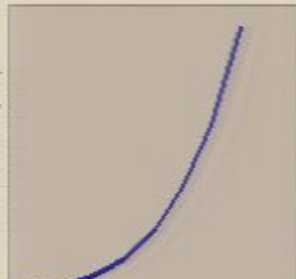
# Understanding Acceleration

- Graphs given to student
- Web cam used to take the videos of the students who walked to get the same graphs
- Graphs analyzed and v-t graphs plotted with d-t graphs on Logger-Pro




Position d(m)

Time t(s)



Position d(m)

Time t(s)



Position d(m)

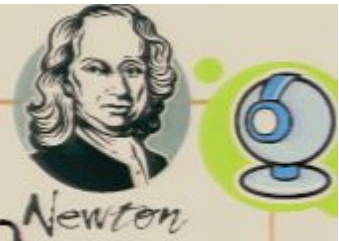
Time t(s)

May 27, 2006

Click to add notes

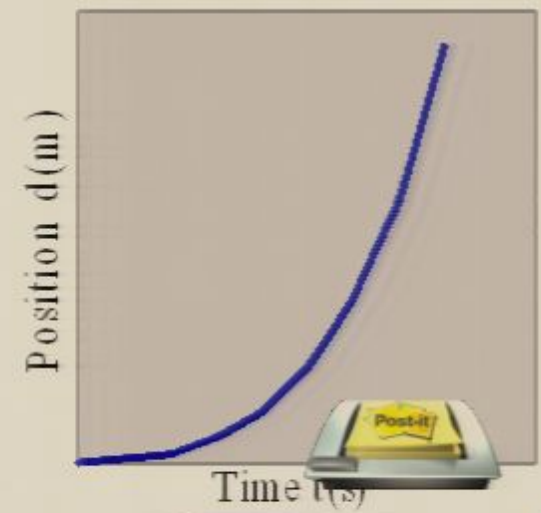
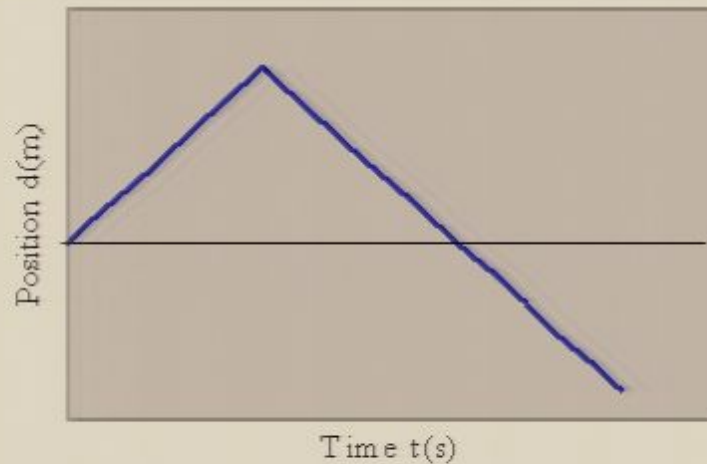
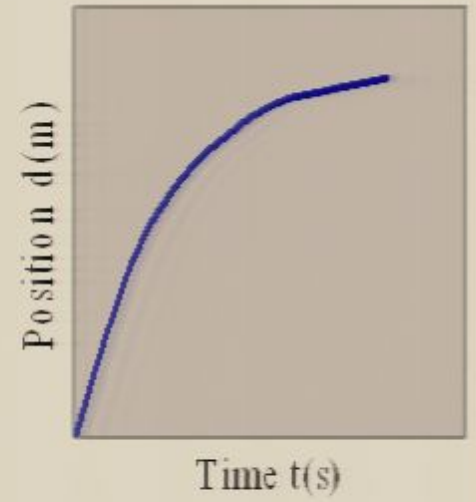






# Understanding Acceleration

- Graphs given to student
- Web cam used to take the videos of the students who walked to get the same graphs
- Graphs analyzed and v-t graphs plotted with d-t graphs on Logger-Pro



# Understanding Acceleration due to Gravity

- Web cam used to take videos of a ball thrown vertically upwards
- The students could check if the throw was vertical
- The video was analyzed by Logger -Pro by plotting d-t and v-t graph for the throw
- Acceleration due to gravity found from the v-t graph



# Advantages of Using Web Cameras



# Advantages of Using Web Cameras

The students



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment





# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience
- can review the videos or pictures at a later tim



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience
- can review the videos or pictures at a later time



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience
- can review the videos or pictures at a later time
- Get more accurate results



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience
- can review the videos or pictures at a later time
- Get more accurate results



# Advantages of Using Web Cameras

The students

- perform the same hands-on experiment
- get a more interactive experience
- can review the videos or pictures at a later time
- Get more accurate results
- ....and it is more fun!!





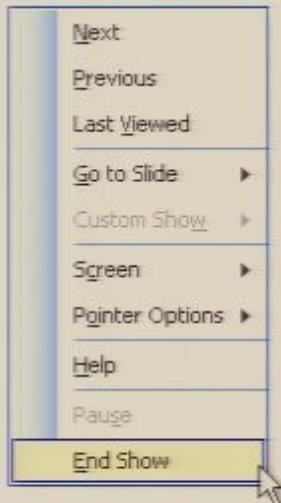
Newton



Thank you!



Newton





Thank you!






- 16 Colliding Elastic or Inelastic
  - Differentiate between elastic and inelastic collisions
  - Calculate initial and final velocities
  - Calculate initial and final momenta
  - Calculate initial and final kinetic energies
  - Check if momentum is conserved
  - Check if kinetic energy is conserved
- 17 Understanding Acceleration
  - Define acceleration
  - Calculate acceleration from a velocity-time graph
  - Calculate distance from a velocity-time graph
  - Calculate time from a velocity-time graph
- 18 Understanding Acceleration using a Graph
  - Calculate acceleration from a velocity-time graph
  - Calculate distance from a velocity-time graph
  - Calculate time from a velocity-time graph
- 19 Investigating Using Web Camera
  - The theory
  - Procedure
  - Results
  - Discussion
  - Conclusion
- 20
  - Newton
  - Thank you!

Newton



Thank you!

May 27, 2006

Click to add notes

