

Gravity Lab – Notes for Teachers

Timing: This lab should take approximately 1.5 hours. There are 2 separate sections with questions after each section. If the students are running low on time, they can leave all the questions until the end or do some of them at home.

Materials:

Each group of 2-3 students will need the following materials –

- 1 laptop with microphone (either built-in or separately attached), Excel, and with the program Audacity installed (see instructions on downloading and installing Audacity below)
- 1-2 calculators
- 1 meter stick (with metric markings)
- 1 piece of string with a metal weight tied at the end and 5 metal washers tied along it at 30cm separation
- 3 pieces of aluminum foil (about 6in long, but the precise size does not matter)
- 1-2 thick textbooks
- 2 large marbles
- 1 ping-pong ball
- 1 cardboard tube (eg: from a paper towel roll)

Prelab Setup:

1. Download and install Audacity according to the instructions below. Make sure the microphone is working properly.
2. Open up Excel and Audacity on each laptop that the students will be using.
3. Hand out materials to the students.

Instructions for downloading and installing Audacity on Mac OS:

1. Go to the website: <http://audacity.sourceforge.net/>
2. Click on “Download Audacity 1.2.6a”
3. Depending on your type of Mac (Intel or PPC), download the appropriate version (If you aren’t sure what kind of processor you have, click on the blue Apple icon in the top left corner of your screen, then click on “About this Mac”. The processor line will tell you whether you have Intel or PowerPC)
4. Once you click on the appropriate link, click Save to Disk. Follow the “Installation Instructions” on that website. Click on the Audacity icon to launch the application.
5. Make sure the microphone is working by clicking the record button and tapping the table next to the computer a few times. To get rid of the recording, go to Edit→Undo

Answers to Basic Lab Questions

Part 1:

Does your data fall along a straight line?

Yes, it should.

What is the slope of the line?

Slope should be approximately 0.045

Use the slope to calculate a value for the acceleration of gravity (g).

Should get a value of approximately 980 cm/s^2

The real gravitational acceleration is 980 cm/s^2 . What is the percent error in your measurement? (percent error = (measured-actual)/actual)

Errors in the 5-20% range are typical.

What is the average velocity between the times when the first and second washer hit the ground? (velocity = change in distance / change in time)

If the washers were tied 30 cm apart, then the average velocity should be approximately 290 cm/s^2

Do the time intervals between the washers hitting the ground increase, decrease, or stay the same as more washers hit? What does this mean about the velocity of the string?

The time intervals decrease meaning the velocity is increasing (due to gravitational acceleration).

Part 2:

Was there a significant difference in the time of falling for the ping-pong ball versus the marble? Does the acceleration of gravity (g) depend on the mass of the object?

There should not be a significant difference in the time or in the measured value of g. The acceleration due to gravity does not depend on the mass of the object!

Which traveled a greater distance overall in the time it took to reach the ground, the marble or the ping-pong ball? What does that mean about the horizontal velocity of each ball as it rolled off the table?

The ping-pong ball travels a greater distance (it flies further horizontally). This means it starts with a larger horizontal velocity.

What would happen if you used a bigger book to make a steeper ramp (but still had the marble roll horizontally off the table) ?

Time to hit the floor would:

increase / decrease / stay the same

Horizontal distance the ball travels would:

increase / decrease / stay the same

Answers to Advanced Lab Questions

Part 1:

Does your data fall along a straight line? Yes, it should.

Why is there a non-zero intercept? What does that value correspond to?

The non-zero intercept is the time from when you first started recording to when the string was dropped.

What is the slope of the line?

Slope should be approximately 0.045

Use the slope to calculate a value for the acceleration of gravity (g).

Should get a value of approximately 980 cm/s^2

The real gravitational acceleration is 980 cm/s^2 . What is the percent error in your measurement? (percent error = (measured-actual)/actual)

Errors in the 5-20% range are typical.

Do the time intervals between the washers hitting the ground increase, decrease, or stay the same as more washers hit? What does this mean about the velocity of the string?

The time intervals decrease meaning the velocity is increasing (due to gravitational acceleration).

If you changed the spacing of your washers to all be 20cm apart and then repeated the experiment, would you expect the slope of the line to change? Explain why not or in which direction?

No, the slope only depends on the gravitational acceleration, which is constant.

If you changed the spacing of your washers to 20cm apart, would you expect the time intervals between the different washers hitting the ground to change as compared to a 30cm separation? Explain why not or in which direction?

If the washers are spaced closer together, you would expect the time intervals to decrease because they will still be moving at the same velocities but will have to travel shorter distances.

For washers spaced 20cm apart:

Predicted time for 1st washer 0.20 s, time for 2nd washer 0.29 s.

Predicted time interval 0.084 s.

