**Introduction**

The first steps in learning to be a good scientist are learning how to take good data, and how to report your results. There will always be some variability in our measurements, even when taking multiple trials. No measurement is ever 100% accurate, and we often introduce irregularities into our data in unavoidable ways. To get the most out of your data you must learn how to recognize and correct for, or limit, the effects of **uncertainty** in your measurements. Measured quantities should always be reported as a **confidence interval.**

**Equipment**

direct

relationship

y∝x

* Stopwatch (or timer app on your phone)
* Meter stick, or 2-meter stick
* Metal ball
* Handout: Statistical Analysis of Data

**Activity**

direct

relationship

y∝x

Your objective is to determine the acceleration due to gravity by measuring the time it takes for a ball to fall off a table. Each person in the class will make a single measurement, and then we will combine our results to get what we hope is a more accurate result.

As you will learn later in your physics class, the time *t* it takes for an object to fall freely due to gravity is related to the distance it falls, *h,* by the formula

(1)

Here *g* is the acceleration due to gravity, which at the surface of the Earth is the same for all objects. Solving for *g* gives

(2)

1. We will drop a single ball from a table. Each person in class will time the drop, and each person will measure the height of the table. Write your own data here:

Time = ­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Height = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Using these values, compute the value for the acceleration due to gravity, *g*. Write your computed value here:

Acceleration due to gravity = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Write your values on the whiteboard in class, so that everyone in class can see all the data. Then copy all the values from the whiteboard to the worksheet page.
2. Using all the data from the class, compute the ***mean*** (average) value for each of:
   1. the time of the drop,
   2. the height of the drop, and the
   3. computed value of the acceleration due to gravity.
3. Using all the data from the class, compute the ***standard deviation*** for each of those quantities.
4. Using the standard deviation, then compute the ***standard deviation of the mean*** (which is a different thing) for each of those quantities.
5. Report the values for each of these quantities in the form of a ***confidence interval***, written as , where represents the mean value (the average) and represents the standard deviation *of the mean* (and not σ, which is the standard deviation *of the distribution*).
6. At the end of class, turn in the worksheet, and when it is returned you should save it for a future exercise.

**Questions to Ponder**

1. If we could take more data, do you think that the standard deviation, σ, would get larger, get smaller, or remain the same?
2. If we could take more data, do you think that the standard deviation of the mean, , would get larger, get smaller, or remain the same?
3. How many digits should you report for the mean value, , given that it’s value is uncertain by the magnitude of the standard deviation of the mean, ?
4. If you were going to invest a lot of time, effort, and money into improving the precision and accuracy of this experiment, which of the two measurements would you focus on?

# **Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Section: \_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Height (h)** | **Time (t)** | **Acceleration (g)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |
| 9 |  |  |  |
| 10 |  |  |  |
| 11 |  |  |  |
| 12 |  |  |  |
| 13 |  |  |  |
| 14 |  |  |  |
| 15 |  |  |  |
| 16 |  |  |  |
| 17 |  |  |  |
| 18 |  |  |  |
| 19 |  |  |  |
| 20 |  |  |  |
| 21 |  |  |  |
| Mean value, |  |  |  |
| Standard Deviation, σ |  |  |  |
| Std. Dev. of the mean, |  |  |  |
| Confidence Interval  , |  |  |  |

Use this space for extra calculations, as needed: