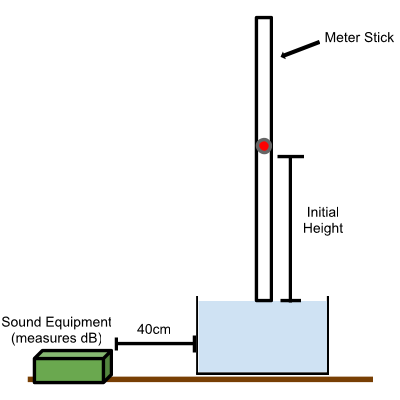
I wish to determine how the initial height of a ball affects the amount of sound produced by the splash it creates in a container of water.

In this experiment I will drop a ball from various heights into a container of water. After I have dropped the ball, I will measure the volume of the splash that the ball has created using electronic equipment that will measure the volume in decibels. The electrical equipment will record the maximum decibel amount. In this experiment, my independent variable is the initial ball height and my dependent variable is the volume of the splash.

There are six variables that I see that can affect the results of this experiment. Therefore, I must control these variables to limit their influence on the data I intend to collect. To effectively control these variables, I must do the following:

* Ball Used
  + For each trial and iteration, I will drop the same ball.
* Container Used to Hold Water
  + For each trial and iteration, I will use the same container to drop the ball into.
* Volume of Water in Container
  + For each trial and iteration, I will drop the ball into a container with the same amount of water inside. Between each trial, I will check the volume of the water and refill it if needed.
* Environment
  + The environmental conditions will be maintained at constantly as possible throughout the course of the experiment.
* Data Recording
  + I will be using the same electrical equipment to measure the decibel amount of the splash. The equipment will be positioned in the same position for each trial and iteration.
* Background Noise
  + I will keep the amount of background noise constant throughout the course of the experiment. I will calibrate for this background noise.

The experiment will proceed as follows. I will drop a ball (diameter=3.5cm) from 6 different heights. A meter stick will be aligned with the edge of the wall to ensure that the measurements of the initial height are indeed vertical. The bottom of the ball will be aligned to the desired initial height. I will than drop the rubber ball into a container ((12 x 18.5 x 9) cm) with 1 L of water in the container. I will than record the (measurement that is presented by the electrical equipment) – (the calibrated white noise that is present in the environment). The electrical equipment used is a device with an attached microphone which measures the analog sound than uses an analog to digital algorithm software to present the decibel value onto a screen fixed on the device.



*\*Not drawn to scale\**

I will repeat this experiment for five iterations before beginning the next trial. The first trial’s initial height will be 40 cm. Each successive trial will increase the initial height by 20 cm and each trial will have five iterations. The experiment will be concluded when six trials are completed.

Initial Height vs. Splash Volume

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trial** | **Initial Height** H / cm ∆H = ± 1.0 cm | **Average Initial Height** ∆H = ± 1.0 cm | **Splash Volume** SV / dB ∆SV = ± 2.0 dB | **Average Splash Volume** ∆SV = ± 2.0 dB |
| **1** | 40.0 | 40.0 | 11.0 | 11.8 |
| 40.0 | 12.0 |
| 40.0 | 13.0 |
| 40.0 | 12.0 |
| 40.0 | 11.0 |
| **2** | 60.0 | 60.0 | 18.0 | 18.0 |
| 60.0 | 17.0 |
| 60.0 | 19.0 |
| 60.0 | 18.0 |
| 60.0 | 18.0 |
| **3** | 80.0 | 80.0 | 21.0 | 21.4 |
| 80.0 | 22.0 |
| 80.0 | 22.0 |
| 80.0 | 20.0 |
| 80.0 | 22.0 |
| **4** | 100.0 | 100.0 | 27.0 | 26.8 |
| 100.0 | 26.0 |
| 100.0 | 28.0 |
| 100.0 | 27.0 |
| 100.0 | 26.0 |
| **5** | 120.0 | 120.0 | 29.0 | 29.2 |
| 120.0 | 30.0 |
| 120.0 | 30.0 |
| 120.0 | 29.0 |
| 120.0 | 28.0 |
| **6** | 140.0 | 140.0 | 34.0 | 33.8 |
| 140.0 | 33.0 |
| 140.0 | 35.0 |
| 140.0 | 33.0 |
| 140.0 | 34.0 |

The splash volume uncertainty is 2.0 dB because when I was testing the sound equipment before the experiment, I found that 2.0 dB was a better representation of the true dB uncertainty rather than 1.0 dB.

The best fit line of this graph has a gradient of 0.2129. This means that the sound volume in decibels increases by this amount for every centimeter of additional initial height. Using a linear fit line, I have an R2 value equal to 0.988, which means that I have a correlation coefficient of 97.6. This is statistically significant and gives hope to my data. However, I am troubled by the fact that the y-intercept is 4.3 decibels above zero. With my data, that would mean that if I dropped the ball from 0 cm, it would still make noise. Either there is an unanticipated systematic error present or the true relationship is not linear. To test the linear nature of my data, I tested what the sound volume would be if I dropped the ball at 0 cm.

This graph, with the tested 0 cm initial height, has a gradient of 0.2286. This means that the sound volume in decibels increases by this amount for every centimeter of additional initial height. The correlation coefficient is 98.0% which is statistically more accurate than the previous graph. This graph has reduced my fear that was presented from the last graph, which was that the y-intercept was being too high and not representing the linear relationship. On this graph, the y-intercept is 2.7; this is within the bounds of experimental error. And after further critical thinking, it makes sense why even when the ball is dropped from 0 cm it still produces sound. This is because the ball’s potential energy is still being converted into kinetic energy (sound) when it is being dropped into the water.

The best fit gradient is calculated to be 0.229.

Calculating maximum and minimum gradients:

Maximum gradient = (35.8 – 1.5) / (139.0 – 1.0) = 0.25

Minimum gradient = (31.8 – 3.5) / (141 – (-1)) = 0.20

The gradient uncertainty would be 1/2(0.25 – 0.20) = 0.025.

Therefore the gradient is **0.229 ± 0.025**.

According to my data, there is a linear relation of ball between the height of which you drop it from and the noise of the splash it creates in a container of water. Both of the graphs support this conclusion. The graphs both have a statistically significant correlation coefficient, which means there is a reasonable about of certainty to this relationship. All the trials support this because when I increased the height of which the ball was dropped from, the sound of the splash also increased. To account for random error, I have taken repeated measurements for each trial performed. To account for systematical errors, I had to do several test runs to accurately drop the ball into the center of the container; for it did not drop in the same position, I would not have been able to get an accurate reading.

Throughout the data recording part of the experiment, I used a room that had a lot of background noise. This made my data was somewhat inaccurate because it to was being recorded by the sound equipment. To account for this background noise, I took the average noise presented by the room and subtracted it from the reading presented by the equipment to get the final dB amount. But still, there may have been a random error that created an unexpected noise which would have made some of my data inaccurate.

Since random error represents the largest uncontrolled uncertainty, I must modify my procedure to reduce or eliminate its effect. To fix this problem of accurately measuring sound of the splash, I propose using multiple sound equipments and using a sound proof room to minimize the surrounding condition variables. By using multiple sound equipments, you would be able to take the average of all the measurements and use that as your trial’s sound volume. By the use of sound meters, you would be able to eliminate some random error that would be presented in the experiment. As well, by using a sound proof room, or a room that presents very little background noise, you would be able to minimize the amount of random errors that would be able to affect the results of the experiment.