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Physics 50 Section 0, Fall 2022
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Module 0 Lab Report
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In this module I determined my reaction time by measuring how far a dropped object fell before I could close my fingers around it. If an object is released from rest and falls a distance d before it is caught, the time between release and catch is $t = \sqrt{\frac{2d}{g}}$, where g is the acceleration due to gravity, or 9.8 m/s^2. If I am trying to catch the object as soon as possible, then this time represents my reaction time: the time for me to realize that the object has been dropped and close my fingers around it. For the object we used a metal ruler (see Figure 1). My lab partner held the ruler and released it at unpredictable times, so that I was truly reacting to external events. My hand was held near the ruler before it was dropped, with my thumb and fingers just a centimeter or so from the front and back of the ruler as shown on the left in Figure 1. This way, the time to actually move my fingers was minimized, and t represents as accurately as possible the time for my neural processes (sensing the drop and sending the motor impulse to my hand).

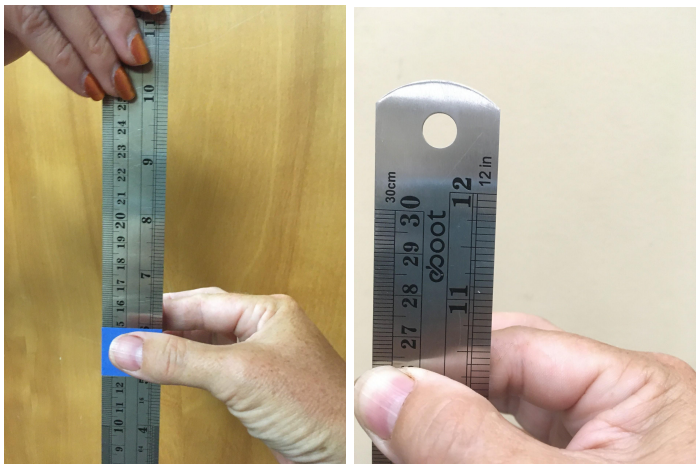

Figure 1: Ruler before being released (left) and after being caught (right). The initial position is set to the top of the blue tape, at 15 cm on the ruler's markings. The measured final position in the image at right is 26.3 cm.

Blue masking tape was used to mark the initial height of my hand. The blue tape was wrapped around the ruler with its top edge at the 15-cm mark. Before each trial, my lab partner held the ruler steady (holding it from the top), while I positioned my fingers about a centimeter away from the ruler so that the top of my thumb and index finger were level with the top of the blue tape. Sometimes my partner's hand shook so this was hard to accomplish, but I estimate variations of no more than 0.3 cm in the initial height of my fingers. My partner then released the ruler and I caught it by pinching my fingers closed, as shown on the right in Figure 1. I

recorded the position of the top edge of my thumb after each catch, using the ruler markings. I subtracted the initial position of 15 cm from this final position to find the distance *d*.

This procedure was repeated ten times, giving an average *d* value of 8.9 cm and an SEM of 1.3 cm. Using $t = \sqrt{\frac{2d}{g}}$ and propagating error through this formula ($\delta t = \delta d \frac{1}{\sqrt{2gd}}$) , we determined my reaction time to be 0.134±0.010 seconds. This is significantly larger than my lab partner's reaction time of 0.115±0.008 seconds, determined by the same method, but similar to the reaction times of some classmates. My lab partner plays a lot of video games, so we speculate that she has trained her reaction time to be shorter through practice.

Based on the standard error in *d*, variation between trials is clearly the dominant source of uncertainty in this experiment. It is much more important than the difficulty of lining up my fingers with the initial tape mark, noted above to cause no more than 0.3 cm of variation. (Note: variation from initial alignment is also already included in the trial-to-trial variation we recorded.) We initially tried this experiment with a clear plastic ruler instead of the metal one, and the variation was even larger with it. We are not sure why the plastic ruler gave less consistent results, but I believe it might be because the transparent ruler made it easier to be distracted by background movement. We used the metal ruler for our official data because it gave more consistent data, leading to a more precise result. However, some variations in the data are still puzzling, as shown by a histogram of *d* measurements (Figure 2).

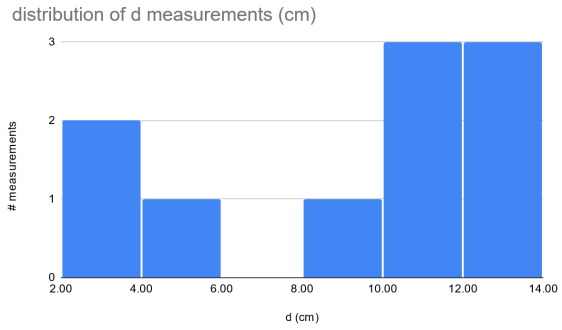

Figure 2: Histogram of individual *d* measurements

Most measurements fall between 8 and 14 cm, but there is a separate cluster of smaller values (2-5 cm). With more trials it might become clearer whether these points are anomalous and should be excluded; with the existing data, excluding the three smallest trials changes the result by less than its uncertainty. It is possible that the smaller measurements were times when I was already closing my fingers before my partner released the ruler. In one or two cases I actually did accidentally grab the ruler while trying to line my fingers up with the tape mark. To reduce the chance of this happening in future measurements, my partner could wait to release the ruler until I had finished lining up my fingers and called out "ready."