

## Uncertainty in Measurement

Course: Patterns Physics

Unit: Patterns and Inquiry

Day 2

Goal: The goal today is for students to be able to make appropriate measurements with a ruler or meter stick and then calculate the average, range, and uncertainty in repeated measurements.

### Materials:

8 Cart and ramp setups (CPO science materials were used in this lesson)

8 hand held timing devices

8 meter sticks

Calculators

Introduction: This is intended as an introduction to reporting uncertainty in measurements. Students need no particular prerequisites for this lesson. As a starter to the lesson students will be shown 2 sets of three measured values. The first set will be relatively less precise. For example: 28,29,30. The second set will be more precise. Eg 28.9, 29.0, 29.1. These number sets will be used to introduce the ideas of; mean average, range, and uncertainty.

average= sum/ number of values

range= difference in largest value and smallest value

uncertainty= range/2

After brief discussion on these topics and question/answer session students will be given a task to incorporate the new material. For example, groups of 4 students in this lesson were instructed to measure the length of their desk in class. This will give 7 or so values that are close to one-another. These measurements can then be given to the instructor and then displayed for class. Using this number set the teacher can point out how to find; average, range, and uncertainty.

Activity: Students will be given instruction on how to measure the amount of time a car takes to roll down a ramp a specific distance. Student groups of 4 will be given different roll distances to record. Each group will be instructed to take 5 measurements of the amount of time for their specific roll distance. Then instruct them to use their 5 values to calculate; average, range, and uncertainty. Students will then add their values to a data table displayed for the class. After all groups have put their three calculated values on the board the teacher should first graph the data (with class help of course), the class will look for a pattern in the data using just the average values. Hopefully the pattern is hard to identify because the resolution of the timing tool is poor enough so that the average values only show a vague pattern. After a class discussion

about the difficulty in using these average values for a curve fit the teacher will add error bars to the average values so the students can see the differences in student data collection techniques and it's impact on large vs. small error bars. Using the error bars on the average data points students should have an easier time curve fitting the data.

Genius in the Classroom addition to lesson:

1. Students will be given opportunity to research any idea that relates to uncertainty in measurement and write a paragraph about what they learned.
2. Students can write a short essay about what could potentially happen if uncertainty in measurement caused some sort of disaster.
3. Students can draw a design for a new sort of tool that could measure length with greater less uncertainty in measurement. Design a better ruler.
4. Students can write a comic strip of any length with the inclusion of the idea of uncertainty in measurement.
5. Students can propose another style of activity to the instructor for approval that includes uncertainty in measurement.