

## Sources of Error

Whenever you conduct an experiment or take part in the engineering design process you will have potential sources of error. Sometimes it's difficult to understand what sources of error are, so this should help!

First of all, when we talk about "sources of error" we are not talking about mistakes that were made in your project. If you made a mistake the best thing to do would be to go back and fix it. Sometimes that's not an option, because a mistake was made that influenced everything else and you don't have time to go back and do it all again. If that's the case, then you definitely want to explain that in your Mission Folder.

But this kind of mistake is not considered a "source of error." Instead, sources of error are essentially sources of uncertainty that exist in your measurements. Every measurement, no matter how precise we might think it is, contains some uncertainty, simply based on the way we measure it. **In fact there are two main types of "error" or "uncertainty":**

1. Systematic
2. Random

**Systematic errors affect the accuracy of a measurement.** They cannot be corrected with repeated measurements because they will always exist. They can be caused by faulty calibration of an instrument, poorly maintained instruments, or even faulty reading of the instrument by a person.

**Random errors are a bit different.** They affect the precision of a measurement. Random errors are caused by problems like reading the measurement between two lines on a measuring device or if the reading fluctuates. These types of errors can be reduced by conducting multiple measurements.

This is a very basic description of the types of error and sources of error in general. Just remember, sources of error are not mistakes that were made in your project, so when you have to discuss "sources of error" don't respond with something like "We didn't do anything wrong. Everything worked." This should be a discussion about uncertainty and what uncertainties existed in your measurements.



### Sources of Error Worksheet

Here you will have the chance to identify sources of error in given situations. First, let's make sure you understand the type of error you may encounter:

What type of error influences the accuracy of your measurements and can come from faulty calibration of an instrument? \_\_\_\_\_

What type of error influences the precision of your measurements and can be limited by taking repeated measurements? \_\_\_\_\_

OK, let's take a look at some scenarios. After each one, you will identify what the sources of error might have been. Remember: Sources of error are not mistakes made by the observer; rather they are possible sources of uncertainty.

Scenario 1:

A group is working on finding the mass of an unknown substance. They are using a digital balance. The first time they take the measurement the balance reads "2.5g." They try again and the balance reads "2.6g." They take one final reading and balance reads "2.5g." They find the mean mass by adding up the values and dividing by three (the number of measurements taken). Their final answer for the mass of the substance is 2.53g.

What are the possible sources of error for this measurement?

Scenario 2:

A group is trying to find the volume of a given liquid. To do this, they are using a graduated cylinder that is graduated by milliliters. They pour the substance into the graduated cylinder and take their reading. One group member says there are 25.5mL. Another group member says it's 25mL exactly and a third group member says they think it's 25.6mL.

What are the possible sources of error for this measurement?



Scenario 3:

A group is working on conducting a survey of their classmates to see if students prefer having lunch before noon, at noon, or after noon. They give their survey to five people. The results they find are that all five students prefer having lunch after noon. The group concludes that all students prefer having lunch after noon.

What are the sources of error in this study?

Scenario 4:

A group of students is working on tracking the growth of a plant over an entire month. Each day one member of the group needs to measure the height of the plant and record it in the group's log book. At the end of the month the groups looks at their data and notices that the numbers went up every day except one where the number went down, but then went up again the next day.

What are the sources of error for the tracking of the plant growth?



### Sources of Error Worksheet

Here you will have the chance to identify sources of error in given situations. First, let's make sure you understand the type of error you may encounter:

What type of error influences the accuracy of your measurements and can come from faulty calibration of an instrument? SYSTEMATIC

What type of error influences the precision of your measurements and can be limited by taking repeated measurements? RANDOM

OK, let's take a look at some scenarios. After each one, you will identify what the sources of error might have been. Remember: Sources of error are not mistakes made by the observer; rather they are possible sources of uncertainty.

Scenario 1:

A group is working on finding the mass of an unknown substance. They are using a digital balance. The first time they take the measurement the balance reads "2.5g." They try again and the balance reads "2.6g." They take one final reading and balance reads "2.5g." They find the mean mass by adding up the values and dividing by three (the number of measurements taken). Their final answer for the mass of the substance is 2.53g.

What are the possible sources of error for this measurement?

**STUDENTS SHOULD DISCUSS SYSTEMATIC ERRORS LIKE POOR CALIBRATION, OLD OR FAULTY MACHINES**

Scenario 2:

A group is trying to find the volume of a given liquid. To do this, they are using a graduated cylinder that is graduated by milliliters. They pour the substance into the graduated cylinder and take their reading. One group member says there are 25.5mL. Another group member says it's 25mL exactly and a third group member says they think it's 25.6mL.

What are the possible sources of error for this measurement?

**STUDENTS SHOULD DISCUSS RANDOM ERRORS LIKE READING OF THE CYLINDER BETWEEN LINES.**



#### Scenario 3:

A group is working on conducting a survey of their classmates to see if students prefer having lunch before noon, at noon, or after noon. They give their survey to five people. The results they find are that all five students prefer having lunch after noon. The group concludes that all students prefer having lunch after noon.

What are the sources of error in this study?

**STUDENTS SHOULD DISCUSS SYSTEMATIC ERRORS LIKE A SMALL SAMPLE SIZE. \*NOTE: THIS IS A MORE DIFFICULT PROBLEM THAT IS NOT EXPLICITLY DISCUSSED IN THE PREVIOUS SHEET.**

#### Scenario 4:

A group of students is working on tracking the growth of a plant over an entire month. Each day one member of the group needs to measure the height of the plant and record it in the group's log book. At the end of the month the groups looks at their data and notices that the numbers went up every day except one where the number went down, but then went up again the next day.

What are the sources of error for the tracking of the plant growth?

**STUDENTS SHOULD DISCUSS SYSTEMATIC ERROR FROM MISREADING A MEASURING DEVICE, OR A POORLY MAINTAINED MEASURING DEVICE. THEY MAY ALSO MENTION ONE STUDENT TAKING AN INCORRECT MEASUREMENT OR RECORDING A MEASUREMENT INCORRECTLY. THEY CANNOT SIMPLY STATE "HUMAN ERROR" THEY MUST BE SPECIFIC.**