1.2: Scientific Experiments

Identify the characteristics of a scientific experiment.

Once we have the common language of measurement, we can start explaining our world to each other. However, how do we determine what those measurements mean? How do we make sense out of what we see and observe? Science is about understanding the world we live in. It involves a way of discovering natural processes and explaining these processes to others using evidence. This involves observation, hypothesizing, and experimentation. For example, suppose you observe that certain flowers in your garden grow better than others. You might hypothesize (try to find a reasonable explanation for) why this occurs. Some reasonable hypotheses might include that one area gets more sun than the other, one area gets more water than the other, or maybe one area has been better fertilized. Whatever the hypothesis, you would then conduct an experiment to find out if your hypothesis was correct. Then you might use the results of your experiment to improve your garden. In this objective, we will discuss how experiments in physical science are performed using scientific methods.

Experiments

Experiments in physical science are often conducted to determine the relationship between two variables. In an experiment there are two kinds of variables: independent variables and dependent variables. Independent variables are things that the experimenter can change directly. Dependent variables cannot be directly changed, but may change when an independent variable has been changed. Another way to look at this is that you change the independent variable to see how that affects the dependent variable. For any experiment it is critical that only one variable be changed at a time. If you change several variables, you won't know exactly which change affected the outcome. So it is important to keep everything constant except for your one independent variable.

Let's look at an example to see things more clearly.

Example 1.1:

A group of students wants to find out the relationship between how far back a slingshot is pulled (we'll call this pull length), and how far a pellet will go (we'll call this pellet distance). They predict that the further back they pull the slingshot, the farther the pellet will go. So they set up an experiment in which they clamp a slingshot on a table. They choose six different pull lengths and measure how far the pellet goes each time they pull.

Now, look at figure 1.2 and think about the four questions below.

Questions:

1. What relationship is being studied?[1]
2. What is the independent variable?[2]
3. What is the dependent variable?[3]
4. What is something that must be kept constant during the six trials?[4]

Fig. 1.2: A scientific experiment

The Results in Metric Units are:

Results

	Pull #1	Pull #2	Pull #3	Pull #4	Pull #5	Pull #6
Pull Length	4 cm	8 cm	11 cm	15 cm	19 cm	23 cm
Pellet Distance	2.1 m	4.1 m	5.6 m	7.9 m	9.6 m	12 m

Two other factors that are important to consider in an experiment are the number of data points recorded and the range of the data. Data points are the measured values for the two variables being tested in the experiment. In the example above, you would measure the pull length and the pellet distance. Each pull length would have a corresponding pellet distance. This is what we call a data point—one value for the independent variable with the corresponding value for the dependent variable. It is essential to have enough data points to clearly establish the relationship between the variables being studied. If you had only measured one pull length and its corresponding pellet distance, that would not be enough to find the relationship. As a general rule of thumb, it is a good idea to measure at least five or six different data points in an experiment. Don't forget that it is the independent variable that we can change, so choose five or six different values for this variable, and measure the resulting values for the dependent variable. This is how you will obtain an adequate number of data points. Another critical factor to consider in an experiment is that the data points be spread out as much as possible. This is what is meant by the range of data. In the example above, it does not mention how spread out the six data points are. If they were all just a few millimeters different, that would not give a very good picture of the relationship. It would be better if each pull length differed by more so the data would spread out more. This way it becomes easier to establish the relationship between the independent and dependent variables.

---

[1] The relationship being studied is the effect of the pull length on the pellet distance.

[2] The independent variable is the pull length. Notice that this is the variable that the students can change directly.

[3] The dependent variable is the pellet distance. Notice that this distance will depend on the pull length. Since it depends on another variable, it is called the dependent variable.

[4] Many things need to be kept constant, but one important one is the angle of launch. Changing the angle while also changing the pull length would make it impossible to tell which one affected the pellet distance.