Designing Experiments

To design a good experiment several steps must be taken to ensure the results are as scientific as possible. Once the objective of the experiment has be determined, scientists must identify all the **variables** or factors which will affect the experiment. Scientists must then identify the different ways **tests** can be conducted to determine the outcome of the experiment. Now the experiment can begin. First a **hypothesis** identifies a variable will affect the outcome of the experiment and includes a **prediction** as to what that outcome will be. The variable selected is called the **independent variable** since it is the one selected and controlled by the experimenters. The effect measured will be the **dependent variable** since its outcome depends on the independent variable.

For example if scientists were looking at how to prevent fruit from spoiling, several factors would be considered such as temperature, adding chemicals, adding radiation or genetically engineering the food. In this case the scientists decide that temperature will have the greatest effect and the prediction is that the cooler the storage temperature, the longer it will take to spoil. The hypothesis would be: If storage temperature affects banana spoilage, then bananas stored at colder temperatures will take longer to spoil. The independent variable is storage temperature and the dependent variable is the time taken to spoil.

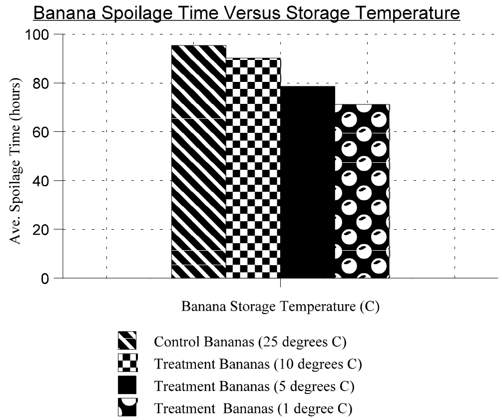
Now the procedure of the experiment must be worked out. Care is taken to only change the variable mentioned in the hypothesis so you can be certain that no other factor is also influencing the results. Two sets of experiments are set up. One is called the **control** and the other is the **treatment**. In the control group, a standard model is tested repeatedly. Each repetition is called a **trial**. In the treatment group, one variable is changed from the standard control model and the effect is measured repeatedly. If the data collected is measurable, such as mass or time, these are called **quantitative observations**; whereas, if the data collected is not measurable, such as colour or odour, these are called **qualitative observations**. The data is collected in a table which shows the results of each trial for both the control and the treatment groups. The average result is also displayed.

For our experiment on fruit spoilage, the control group will be using bananas of approximately the same weight (about 300 grams) and degree of ripeness (all yellow, no spots) stored at 25°C until the first brown spot appears. Time, (quantitative observations) will be measured in hours. Five bananas are tested and the results recorded. The treatment group is the same as the control group except the bananas are now stored at 10°C, 5°C and 1°C. The data for 20 bananas is recorded below:

Experiment Group	*Time to Spoil (hours)*					*Average Time to Spoil (hours)*
	Banana 1	*Banana 2*	*Banana 3*	*Banana 4*	*Banana 5*	
Control (25°C)	*96*	*87*	*101*	*94*	*99*	*95.4*
Treatment (10°C)	*92*	*94*	*87*	*90*	*88*	*90.2*
Treatment (5°C)	*75*	*72*	*85*	*82*	*79*	*78.6*
Treatment (1°C)	*65*	*64*	*71*	*80*	*76*	*71.2*

The data is also graphed showing both the control group average result and the treatment group average result. The results are always graphed by placing the independent variable data on the x-axis and the dependent variable data on the y-axis. The title is always <u>Dependent Variable Versus Independent Variable</u>.

For our experiment, the graph would look as follows:



Now that the data has been studied, the write-up can be prepared. The following sections: **Hypothesis** (with prediction)**, Procedure**, **Observations** (includes the data table and graph) and finally the **Conclusion**. In the conclusion, scientists describe any cause and effect relationships that were apparent. This is used to state whether the prediction and hypothesis were accepted or rejected. Finally an attempt is made to explain the results.

The conclusion for our experiment would be as follows:

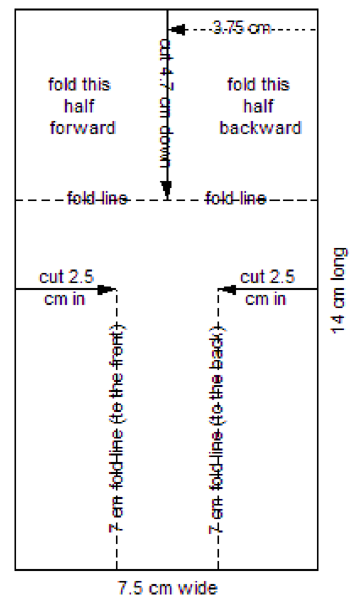
<u>Conclusion:</u> *From the graph, it is apparent that bananas spoil faster at a colder temperature which contradicts the prediction made in this experiment, but does support the hypothesis that temperature effects fruit spoilage. This may be due to the fact that the bananas in the colder temperature were stored in a refrigerator without light. Also any gases produced by the fruit over time as it begins to spoil would accumulate faster insider the refrigerator which would then serve to speed up the spoiling process. Furthermore, colder temperatures maybe injure the bananas which quickly increaser spoilage.*

Falling Rotocopters

The experiment that we are going to do today simulates helicopter flight. Helicopter manufacturers are always trying to improve the design of helicopters to ensure that if, unfortunately, something should happen and a helicopter is going to crash, survival of the occupants could be made more likely. One way to do this, is to increase the amount of time the helicopter remains in the air so it will not crash too quickly and with less force. Therein lies the problem, how do you make helicopters stay in the air longer as the fall?

We are going to make rotocopters out of stiff paper to simulate helicopter crashes. The design plan is given below. You need to think of one variable which may effect the "air-time" of the rotocopter. Make sure you make one control copter and at least three different treatment copters (if needed). Also you need to make sure you run at least 5 trials for each copter. Before you do any tests, you should make your hypothesis (and prediction).

Control Rotocopter Design: use file folder paper according to the adjacent plan (not proper size, you must measure)



The Report:

Prepare a presentation including the following:

a) state your hypothesis (an if/then statement outlining the variable you thought would affect the experiment and your prediction of the outcome of changing this variable).
b) state your procedure outlining how you designed your rotocopters, tests done and measurements taken.
c) draw a proper data table on one half of a large piece of paper.
d) draw a proper graph for your data showing the average results.
e) state whether your prediction was correct and explain how you determined this.
f) state whether your hypothesis is correct and explain how you determined this.
g) attempt to explain your results