# Scientific Investigation Guidelines

<table>
<tr><td rowspan="3">I can ask a question and write a hypothesis</td><td>Investigative Question<br>  </td><td>Introduces the purpose and is a question that is testable by scientific methods. There are two criteria:<br>1. Correct form(s): You choose which one to use<br><br>A. How does (the manipulated variable) affect (the responding variable)?<br>B. What effect does (the manipulated variable) have on (the responding variable)?<br>2. Correct variables:<br>Use the manipulated and the responding variable<br><br>Examples: What effect does speed have on kinetic energy?<br>How does speed affect kinetic energy?</td></tr>
<tr><td>Hypothesis<br>  </td><td>A hypothesis has to have a claim (in the form of a prediction) and reasoning.<br>The hypothesis does not have to be correct, it has to be thoughtful and have a scientific principle.<br><br>Claim:<br>When doing an experiment with multiple trials write your hypothesis this way:<br>If (the manipulated variable) is (describe how you will change it),<br>then (the responding variable) will (describe the effect of the change)<br>Reasoning:<br>because (explain why you believe it will happen based on a scientific principle – or back ground knowledge).<br><br>Other times it can be as simple as:<br>I (believe, think, predict…) that (the manipulated variable) will affect (the responding variable) by (explain the way it will be affected), because (explain why you believe it will happen).<br><br>Example: If the light's distance is increased, then the energy of the light will decrease because light spreads out as it travels and the more spread out it gets the weaker it gets.</td></tr>
<tr><td>Variables<br>  </td><td>All variables need to include the variable and its quality. (“Amount of time” not just “Time”)<br><br>Manipulated Variable (MV) (Independent variable): The factor being tested and purposely changed by the experimenter<br><br>Responding Variable (RV) (Dependent variable): The factor being measured and recorded<br><br>Controlled Variables: The factor(s) <u>kept the same</u> from trial to trial to ensure it is the manipulated variable causing the change</td></tr>
</table>

<table>
<tr><td rowspan="2">I can design a scientific investigation</td><td>Materials<br>  </td><td>The criteria for the materials list are:<br>• Complete<br>• Bulleted list<br>• Amounts are indicated (where appropriate)</td></tr>
<tr><td>Procedure<br>  </td><td>The criteria for the procedure are:<br>1. Complete/ logical steps<br>2. All variables implied<br>3. Says to record data: Name the responding variable<br>4. Says to repeat steps</td></tr>
</table>

# Scientific Investigation Guidelines

## I can collect and analyze experimental data

### Observations
*(Qualitative Data)*

*Observations are what you see occurring in the experiment, both in the experiment itself and things your group does that may impact the experiment such as spills, bumps and accidents.*
*The criteria for observations are*

- ***Indicate what and when***
- ***Bulleted list***

### Table
*(Quantitative Data)*

***The criteria for tables are:***

- *Title (MV vs. RV)*
- *Variables labeled correctly*
- *All units labeled*
- *Correct data and type*

For experiments with multiple trials use this table

**MV vs. RV**

| *MV (units)* | *RV (units)* | | | *Average (units)* |
|---|---|---|---|---|
| | *Trial 1* | *Trial 2* | *Trial 3* | |
| *Level of MV* | *Data* | *Data* | *Data* | *Average of data* |
| *Level of MV* | *Data* | *Data* | *Data* | *Average of data* |
| *Level of MV* | *Data* | *Data* | *Data* | *Average of data* |

Other tables will be used according to the situation

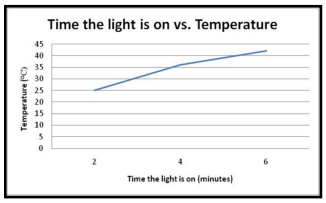
### Graph
*(Quantitative Data)*

The type of graph you use is dependent on the data you collect

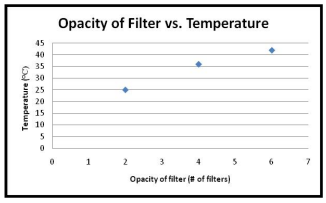
***The criteria for graphs are:***

- *Title (MV vs. RV)*
- *Variables labeled correctly*
- *All units labeled*
- *Correct data and type used*

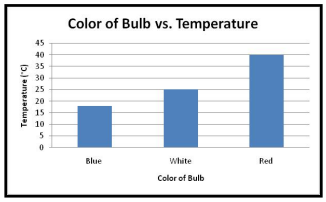
**Line graphs**
*These are used to represent continuous data such as how something changes over time.*




**Dot graphs (Scatter Plots)**
*These are used to represent the relationship of two variables that are not continuous. Such as three separate distances or number of filters. They are all the same type of data, but they are not continuous.*




**Bar graphs**
*These are used to represent different categories of data, such as different colored light bulbs compared to a responding variable. Each color would be a different category.*
*(No units are needed on the x axis.)*



# Scientific Investigation Guidelines

| | | |
|---|---|---|
| **I can collect and analyze experimental data** *(Continued)* | **Analysis**  | The analysis is where the experimenter analyzes their data and indicates what they notice. All three parts must be mentioned (whether it happened or not) and they must be written in complete sentences. The criteria are:<br>• **P**atterns or trends in your data. – *Use the average data for patterns*<br>• **O**utliers or unusual events – *Identify data that does not fit the pattern you identified*. Look in the trials for this data ***(If there were none, indicate that there were none.)***<br>• **P**ossible variables that were not controlled - *Indicate variables that were not controlled that should have been that may have caused the outliers. **If no outliers or errors were evident, you still must tell what variables you could have controlled that you did not.***<br>• ***L**imitations – Identify how the experiment is limited. What can't it tell you? What did you not test that might give different results?*<br>***Example***<br>• *After the experiment I noticed that as the _____(mv)____ increased the _____(rv)_____ also increased. This pattern was consistent for every trial, so there were no outliers. Although there were no outliers, we did not control _____ which could have caused _____. This is experiment is limited because we only tested _____.* |

| | | |
|---|---|---|
| **I can use experimental data to make conclusions** | **Conclusion**  | *The conclusion summarizes the entire experiment and opens the door to another experiment. It must address **all 6 parts** below in a continuous paragraph with complete sentences.*<br>• **R**estate the investigative question<br>  ○ *Express the purpose of the experiment*<br>  ○ *Always start with "The purpose of this experiment was to …" or something similar*<br>• **A**ccept or reject hypothesis<br>  ○ *Summarize your hypothesis*<br>  ○ *Tell whether the experiment supported (confirmed) or refuted (proved incorrect) your hypothesis*<br>• **S**upport with data<br>  ○ *Use average high and low data as evidence of what happened in the experiment*<br>• **M**ake a claim<br>  ○ *Make a statement about what you now believe based on the evidence gathered in the experiment*<br>• **I**dentify improvements<br>  ○ *How could the experiment be done better?*<br>• **A**sk a new question *(investigative question)*<br>  ○ *Write a new **investigative question*** (in proper form*) to further your understanding*<br>***Example***<br>*The purpose of this experiment was to see what effect _____(mv)_____had on _____(rv)_____. My experiment confirmed my hypothesis that if the _____(mv)_____ is increased than the _____(rv)_____ will also increase. This can be seen in our average data from the experiment. When the _____(mv)_____. was _____ the _____(rv)_____ was (average data with units), and when the (MV) was _____ the (RV) was (average data with units). From this data we can say that the higher the _____(rv)_____ the higher the _____(rv)_____. This experiment could be improved if we have done a better job controlling _____ This now leads me to wonder how the _____(new - mv)_____. affects the _____(new-rv)_____.* |

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