Processing and Evaluating

Inquiring and Designing

Evaluate

Evaluate the hypothesis
pg 8

Define variables and define the problem
pg 3

Evaluate the method and suggest improvements
pg 8

Evaluate the hypothesis based on evidence
pg 3

Explain how to change and measure variables
pg 3

Inquire

Design

Process

Collect raw data, then process and present it
pg 5-6

Design clear and safe procedure with materials
pg 4

Explain your data using patterns
pg 7

Criterion C

Criterion B

Based on the MYP experimental cycle from the MYP Science Guide page 14

Created by Brian Neises 2014. Acknowledgements on last page.
How do I scientifically inquire?
The Scientific Method

**INQUIRING AND DESIGNING**
Criterion B
The first part of any inquiry will be deciding on what question you will try to answer, and then how you will answer the question. In science you must be very detailed BEFORE you do your experiment!

This part of your process will include:
- Variables (B.iii)
- Defining the Problem (B.i)
- Hypothesis (B.ii)
- Procedure (B.iv)
- Materials (B.iv)

**PROCESSING AND EVALUATING**
Criterion C
After you have properly planned your inquiry and submitted your materials list, you may conduct your investigation!

You will collect your data, then process it to create graphs and tables. This will help you evaluate your hypothesis by finding patterns in the data. You will finish by evaluating your method and suggesting improvements.

This part of your process will include:
- Collecting Raw Data (C.i)
- Data Processing (C.i)
- Processed Data Table (C.i)
- Graphing (C.i)
- Patterns (C.ii)
- Evaluating the Hypothesis (C.iii)
- Evaluating the Method (C.iv)
- Suggesting Improvements (C.v)
Inquiring

Variables (B.iii)

Variables are the part of your experiment that you will change and measure. Choosing appropriate variables will also help you make it a fair test. In a scientific inquiry you will change only one type of thing, and only measure one type of thing. The rest of the things you could change, you must actually keep the same!

**Independent variable**
- the variable you decide to change
- always choose a range based on research
- make sure to include appropriate labels

**Dependent variable**
- what you will measure
- make sure it is able to be measured using numbers!

**Controlled variables**
- all the things you will keep the same
- make sure you describe what they should be, and how you will make sure they stay that way!

Defining the Problem (B.i)

When you put your independent and dependent variables together, you can form a question that you will try to answer through your experiment. Your research question is what you are trying to answer when you write your conclusion or form your hypothesis. You must also explain why this is a problem that needs to be tested.

**Research Question Is Testable**
- this means it can be measured
- what units will you measure with?

**You don’t already know the answer**
- if you already know the answer, don’t waste your time experimenting!
- if you can easily find the answer on google, then maybe it’s not the best experiment

**Does not try to test too much**
- it is not too large of an experiment that will take longer than you have to test, and write up your report

Hypothesis (B.ii)

Your hypothesis is a statement you make BEFORE you do your experiment, that describes what you think will happen. Our hypotheses are often wrong, and that’s ok! After your experiment you will see if your data supports or contradicts your hypothesis.

**Prediction**
- what you think will happen
- refers to the independent and dependent variables

**Evidence**
- a description of why you made your prediction
- you should use sources such as books, magazines, the internet, or other lab reports and experiments
- make sure to cite your sources!

**Format**
- written in a format like: “If I (increase/decrease) my (independent variable), the (dependent variable) will (increase/decrease), because (reasons with information and citation of sources).”
Designing

Procedure (B.iv)

Your procedure is a very detailed description of what you PLAN to do, not a record of what you changed. If you change anything, you can discuss it in your EVALUATION. Make sure to write a procedure that not just you understand, but that is good enough that someone from another school could do your experiment exactly the way you did!

Clear and easy to follow
• use proper vocabulary
• use the variables in your procedure
• use the quantities in your materials list
• use a numbered list to help others know the steps and the order
• have someone proof read your instructions and see if it makes sense to them

Controlled variables
• make sure you describe how you will make sure they stay the same as part of your procedure!

Data
• include how you will collect your data
• more data is better! don’t just test once, why not 3, 5, 10, or 20 times?

Materials (B.iv)

The materials you need for your lab are very important. Many students forget to ask for proper materials, and then cannot complete their lab. It is important that you think through what you will need, and specifically ask for it before the lab is supposed to start.

Materials Request
• if you do not make a request in enough time, you may not be able to get the materials you need for your lab
• if you’re not sure we have something...ask!

Be Specific!
• you get what you ask for!
• someone else should be able to read your list and go get you everything you need, if they can’t, then you weren’t specific enough!

Quantity
• don’t ask for “water” or a “beaker”, but “250ml of water” or a “500ml beaker”
• not “salt” but “10g of salt”
Process

Collecting Raw Data (C.i)

Raw data is data that you collect in the experiment. Usually we use a table to collect the data if it is measured. It is also possible to write our observations as sentences, or to take pictures or video for further evidence.

Do it before the experiment
• don’t wait until you start the experiment to figure out how to record your data, do it as part of the plan before you start

Can it be messy?
• as long as you can read it!
• you’ll be doing a final version in your lab report

Where do the variables go?
• independent on the LEFT
• dependent on the RIGHT

No labels in the tables
• DO NOT include labels in the table, only include them in the title boxes!

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>Temp #1 (C)</th>
<th>Temp #2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>60</td>
<td>17</td>
<td>16</td>
</tr>
</tbody>
</table>

Data Processing (C.i)

After you have completed your experiment you will need to process your raw data. Do you need to find the mean, median, or mode? Maybe a percentage, total, or difference is best? How about a t-test? It will depend on your data!

No averages!
• find the mean, median, or mode not the average!
• you may need to find more than one depending on your data

Show your work
• include the formulas used
• include one example of your processed data for each different type of formula you used

Explain in words
• include a few written sentences to explain why you chose the formula you did
• don’t just say, “because I have to process my data”!

Processed Data Table (C.i)

After you have processed your data, you need to present it in a second table. This will be the table that you use to make your graph, and your conclusion.

New table
• create a second table after your data processing section
• DO NOT just add a section on to your raw data table, it should be a separate table

Smaller table
• yes, it is going to be smaller than the raw data table!
• do not include all the raw data in the new table, just the processed data

Variables
• independent variable in the left column
• dependent variable in the right column(s)
Process Graphing (C.i)

Use your processed data to create a graph that shows the results of your experiment. It should be neat, including proper titles, and must be the proper type of graph!

Type of graph
- depends on the type of data your independent variable produces
- continuous data = line graph or scatter plot
- discreet data = bar or pie chart

Don't forget to include...
- title
- x and y axis
- axis titles including units
- proper scale of numbers

Computer or hand drawn?
- both are fine, but the computer doesn't always make good science graphs, sometimes it is quicker and easier to draw them by hand
- hand drawn graphs need to be neat!

Continuous data
- data that could be any number on a continuum
- starts, changes, stops
- changes over time are usually continuous
- imagine the slope of a hill

Discreet data
- data that has only certain options
- imagine a set of steps
- number of people, shoe size, type of exercise are all types of discreet data
- whenever you create groups you create discreet data, i.e. 0-5 minutes, 6-10 minutes, 11-15 minutes are discreet groups even though time is usually continuous
- if you want to compare different groups, or show which group is the largest, then a vertical line diagram is best
- if you want to compare parts of a whole, then a pie chart is best
Process Patterns (C.ii)

Before evaluating your hypothesis you need to first identify the patterns in the data. Is the dependent variable increasing or decreasing? Is there a linear relationship, or exponential? How exactly are the variables related or not related?

**Increase, decrease, or constant**
- data does not go “up”, it increases
- data does not go “down”, it decreases
- data does not stay the same, it is constant
- sometimes data does 1, 2, or all 3 of these at different points

**Relationships between variables**
- direct = both increase, or both decrease
- indirect = they are opposite

**Common graph types**
- is this a linear relationship, can you represent it with a line of best fit?
- is this an exponential relationship?
- do you see a normal distribution?
Evaluation
Evaluating the Hypothesis (C.iii)
When you evaluate your hypothesis, you will be discussing if it was supported or not. This should reference your data, graph, and the patterns you found. Make sure to have a very clear statement of your final conclusion.

Did you prove it?
• you cannot prove your hypothesis correct, you can only support it
• make sure to discuss the data that supports your thinking

Data, data, data
• make sure to discuss the data, actually use numbers with units to discuss your findings
• refer to the table and graph to help support your thoughts

Research
• have you found information elsewhere to support your ideas? if so, then use a proper citation

Evaluating the Method (C.iv)
Your method probably wasn’t perfect, that’s ok, as long as you discuss the issues. There are two types of errors in your method, the first type is reliability. Reliability according to Worthen is “The measure of how stable, dependable, trustworthy, and consistent a test is in measuring the same thing each time” (1993).

The second type of error in method is validity. Worthen describes a method as being valid in “the degree to which they accomplish the purpose for which they are being used” (1993). Meaning, does your method actually measure what you are trying to measure.

Reliability of Method
Consistency
• did your method allow for a consistent set of data to be collected, or did the measurements change because of your method?
• two people measuring the same thing differently is an issue with reliability

Measuring tools
• using poor tools to measure may affect reliability
• counting out loud is not a very reliable way to measure time, a stopwatch is much more reliable

Validity of Method
Proper variables
• make sure your variables are actually the correct ones to assess what you’re trying to investigate
• if you’re interested in health, is measuring someone’s weight the most valid measurement, or would BMI be better?

Proper tools
• make sure your measurement tool is the proper way to measure your variable
• if you want to measure the change in acidity, then blue-red litmus paper will not give you a valid set of data, you may need a pH probe

Suggesting Improvements (C.v)
Now that you have identified areas of reliability and validity that need improvement, make sure to suggest specific ways to improve on these.

Specific
• your suggestions should be very specific, not “try harder” or “do more”

Realistic
• make sure that your suggestions are realistic
• this does not mean that you cannot suggest using equipment that we do not have though! Just don’t suggest using lightsabers!

Research
• you may need to do a bit of research to find suggestions. “I don’t know” is not acceptable. Find out!
Lab Safety Procedures!
Attitudes in Science

Safety and Emergency Procedures:

1. Always do your best to assure the safety of your classmates and yourself. Be aware of your surroundings and be careful when you move around.

2. Wash hands with soap and water after experiments or handling animals.

3. If you catch on fire: stop, drop, and roll. Know the location of the fire blanket.

4. Let your teacher know right away if glass or anything else breaks.

Lab Instructions and Clean-up:

1. Make sure that no solids go down the sink drains (sand, dirt, plant parts, etc.).

2. Shoes are recommended.

3. Tie back your hair and wear goggles when using an open flame or harmful chemicals.

4. Wash and put away materials as instructed. Clean up your work area, washing the table if necessary. No team member leaves until table clean up is finished.

Rules:

1. Read all procedures and ask questions if necessary. Follow directions and class rules.

2. No Food! Never taste or drink anything in the lab.

3. Absolutely no horseplay. The consequences will be immediate removal from the room, no excuses.

4. Treat living things humanely.
**B.iii** Independent variable (x axis)

| Data Range: |

**B.iii** Dependent variable (y axis)

| How will I measure this: |

**B.iii** Controlled variables

| How will I make sure these stay the same: |

**B.i** Define the Problem

How is the___________________, dependent on ____________________?

**B.ii** Hypothesis : What I predict, with support from sources

IF I ________________________ the __________________________

THEN the ________________________ will ________________________

BECAUSE

**B.iv** Procedure : Step-by-step list of what I will do

**B.iv** Materials : Specific list of what I need, including quantities
MYP SCIENCE LAB REPORT

C.i Raw Data

C.i Data Processing: Write the formulas you use, and show a few examples

C.i Processed Data Table: A new table with only your processed data

C.i Graph: Attach your graph to the back of the lab write-up sheet

C.ii Patterns: Explain what your data using words like increase or decrease
Evaluating the Method & Suggesting Improvements: Discuss the reliability and validity of your method, and suggest improvements. (add as many points as you need)

<table>
<thead>
<tr>
<th>Method</th>
<th>Significance (low, moderate, high)</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>
## Criterion B: Inquiring & Designing

<table>
<thead>
<tr>
<th>Level</th>
<th>The student is able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>i. select a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. select a testable prediction</td>
</tr>
<tr>
<td></td>
<td>iii. state a variable</td>
</tr>
<tr>
<td></td>
<td>iv. design a method with limited success.</td>
</tr>
<tr>
<td>3-4</td>
<td>i. state a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. state a testable prediction</td>
</tr>
<tr>
<td></td>
<td>iii. state how to manipulate the variables, and state how data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a safe method in which he or she selects materials and equipment.</td>
</tr>
<tr>
<td>5-6</td>
<td>i. state a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. outline a testable prediction</td>
</tr>
<tr>
<td></td>
<td>iii. outline how to manipulate the variables, and state how relevant data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a complete and safe method in which he or she selects appropriate materials and equipment.</td>
</tr>
<tr>
<td>7-8</td>
<td>i. outline a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. outline a testable prediction using scientific reasoning</td>
</tr>
<tr>
<td></td>
<td>iii. outline how to manipulate the variables, and outline how sufficient, relevant data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment.</td>
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</tbody>
</table>

## Criterion C: Processing & Evaluating

<table>
<thead>
<tr>
<th>Level</th>
<th>The student is able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>i. collect and present data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. interpret data</td>
</tr>
<tr>
<td></td>
<td>iii. state the validity of a prediction based on the outcome of a scientific investigation, with limited success</td>
</tr>
<tr>
<td></td>
<td>iv. state the validity of the method based on the outcome of a scientific investigation, with limited success</td>
</tr>
<tr>
<td></td>
<td>v. state improvements or extensions to the method that would benefit the scientific investigation, with limited success.</td>
</tr>
<tr>
<td>3-4</td>
<td>i. correctly collect and present data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. accurately interpret data and outline results</td>
</tr>
<tr>
<td></td>
<td>iii. state the validity of a prediction based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>iv. state the validity of the method based on the outcome of a scientific investigation</td>
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<td>v. state improvements or extensions to the method that would benefit the scientific investigation.</td>
</tr>
<tr>
<td>5-6</td>
<td>i. correctly collect, organize and present data in numerical and/or visual forms</td>
</tr>
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<td></td>
<td>ii. accurately interpret data and outline results using scientific reasoning</td>
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<td></td>
<td>v. outline improvements or extensions to the method that would benefit the scientific investigation.</td>
</tr>
<tr>
<td>7-8</td>
<td>i. correctly collect, organize, transform and present data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. accurately interpret data and outline results using correct scientific reasoning</td>
</tr>
<tr>
<td></td>
<td>iii. discuss the validity of a prediction based on the outcome of a scientific investigation</td>
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<td>iv. discuss the validity of the method based on the outcome of a scientific investigation</td>
</tr>
<tr>
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<td>v. describe improvements or extensions to the method that would benefit the scientific investigation.</td>
</tr>
</tbody>
</table>
## Task Specific Clarifications

### MYP Lab Report

<table>
<thead>
<tr>
<th>B</th>
<th>i. outline an appropriate problem or question to be tested by a scientific investigation</th>
<th>ii. outline a testable prediction using scientific reasoning</th>
<th>iii. outline how to manipulate the variables, and outline how data will be collected</th>
<th>iv. design scientific investigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>I have selected a problem from those provided.</td>
<td>I have stated a hypothesis from those provided.</td>
<td>I have stated a variable.</td>
<td>I have a procedure written down for my lab.</td>
</tr>
<tr>
<td>3-4</td>
<td>I have stated a problem as a research question.</td>
<td>My hypothesis is testable.</td>
<td>I have stated how to manipulate the independent variable, and stated how to measure the dependent variable.</td>
<td>My procedures are safe. I have selected the materials I will need.</td>
</tr>
<tr>
<td>5-6</td>
<td>I have stated a problem as a research question that connects with our topic.</td>
<td>My hypothesis is testable, and includes my variables.</td>
<td>I have given brief details on how to manipulate the independent variable, and stated how to measure the dependent variable to collect relevant data.</td>
<td>My procedures are safe and complete. Someone else could probably do my lab because I describe how to work with the variables and collect data. I have selected every material I will need, including quantities.</td>
</tr>
<tr>
<td>7-8</td>
<td>I have given brief details on how my problem is connected to the topic we are studying. I have stated the problem as a research question.</td>
<td>My hypothesis is testable, and includes my variables, with my reasons as a ‘because’ statement.</td>
<td>I have given brief details on how to manipulate the independent variable, how to measure the dependent variable to collect relevant data, and how to manipulate the controlled variables.</td>
<td>My procedures are safe, complete, and logical. Someone else would have no problem with my lab because I describe how to work with the variables and collect data. I have selected every material I will need, including quantities, and I won’t need to ask for anything on the day of the lab.</td>
</tr>
</tbody>
</table>

### C

<table>
<thead>
<tr>
<th>i. present collected and transformed data</th>
<th>ii. interpret data and outline results using scientific reasoning</th>
<th>iii. discuss the prediction of a hypothesis based on the outcome of the scientific investigation</th>
<th>iv. discuss the validity of the method</th>
<th>v. describe improvements or extensions to the method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>I have presented the data I collected in my experiment using tables or graphs.</td>
<td>I have attempted to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis.</td>
<td>I have stated how I suggest improvement to my procedures.</td>
</tr>
<tr>
<td>3-4</td>
<td>I have presented the data I collected in my experiment by using the correct type of graph, including titles, axis labels.</td>
<td>I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis by stating if it has been supported or not, based on my data.</td>
<td>I have stated how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td>5-6</td>
<td>I have organized the data I collected in my experiment using tables that include units in the proper place. My graph is the correct type, including titles, axis labels, and I have used lines of best fit.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis by briefly mentioning the data to state if my hypothesis has been supported or not, based on my data.</td>
<td>I have given brief details of how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td>7-8</td>
<td>I have correctly organized the data I collected in my experiment using tables that include units in the proper place. I have processed my data using proper methods and showed examples. My graph is correct, including titles, axis labels, and I have used lines of best fit.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have correctly given some details of how and the variables are related.</td>
<td>I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.</td>
<td>I have provided details of how I suggest improvement to limitations in my procedures. These suggestions are realistic and based on scientific reasoning and research.</td>
</tr>
</tbody>
</table>
Criterion B: Inquiring & Designing

The student is able to:

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<th>Level</th>
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<td>i. state a problem or question to be tested by a scientific investigation, with <strong>limited success</strong>&lt;br&gt;ii. state a testable hypothesis&lt;br&gt;iii. state the variables&lt;br&gt;iv. design a method, with limited success</td>
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<tr>
<td>3-4</td>
<td>i. state a problem or question to be tested by a scientific investigation&lt;br&gt;ii. outline a testable hypothesis using scientific reasoning&lt;br&gt;iii. outline how to manipulate the variables, and state how <strong>relevant data</strong> will be collected&lt;br&gt;iv. design a <strong>safe</strong> method in which he or she selects materials and equipment</td>
</tr>
<tr>
<td>5-6</td>
<td>i. outline a problem or question to be tested by a scientific investigation&lt;br&gt;ii. outline and explain a testable hypothesis using scientific reasoning&lt;br&gt;iii. outline how to manipulate the variables, and outline how <strong>sufficient, relevant data</strong> will be collected&lt;br&gt;iv. design a complete and safe method in which he or she selects appropriate materials and equipment</td>
</tr>
<tr>
<td>7-8</td>
<td>i. describe a problem or question to be tested by a scientific investigation&lt;br&gt;ii. outline and explain a testable hypothesis using correct scientific reasoning&lt;br&gt;iii. describe how to manipulate the variables, and describe how <strong>sufficient, relevant data</strong> will be collected&lt;br&gt;iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment.</td>
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Criterion C: Processing & Evaluating

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<tr>
<td>1-2</td>
<td>i. collect and present data in numerical and/or visual forms&lt;br&gt;ii. accurately interpret data&lt;br&gt;iii. state the validity of a hypothesis with <strong>limited reference</strong> to a scientific investigation&lt;br&gt;iv. state the validity of the method with <strong>limited reference</strong> to a scientific investigation&lt;br&gt;v. state limited improvements or extensions to the method</td>
</tr>
<tr>
<td>3-4</td>
<td>i. correctly collect and present data in numerical and/or visual forms&lt;br&gt;ii. accurately interpret data and describe results&lt;br&gt;iii. state the validity of a hypothesis based on the outcome of a scientific investigation&lt;br&gt;iv. state the validity of the method based on the outcome of a scientific investigation&lt;br&gt;v. state improvements or extensions to the method that would benefit the scientific investigation</td>
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</tr>
<tr>
<td><strong>B</strong></td>
<td>1. describe a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td><strong>1-2</strong></td>
<td>I have stated a problem as a research question.</td>
</tr>
<tr>
<td><strong>3-4</strong></td>
<td>I have stated a problem as a research question that connects with our topic.</td>
</tr>
<tr>
<td><strong>5-6</strong></td>
<td>I have given brief details on how my problem is connected to the topic we are studying. I have stated the problem as a research question.</td>
</tr>
<tr>
<td><strong>7-8</strong></td>
<td>I have provided details on a problem I want to investigate, and how it is connected to the topic we are studying. I have stated the problem as a research question that includes my variables.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>C</strong></th>
<th>i. present collected and transformed data</th>
<th>ii. interpret data and describe results using scientific reasoning</th>
<th>iii. discuss the validity of a hypothesis based on the outcome of the scientific investigation</th>
<th>iv. discuss the validity of the method</th>
<th>v. describe improvements or extensions to the method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1-2</strong></td>
<td>I have presented the data I collected in my experiment using tables or graphs.</td>
<td>I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis by stating if it has been supported or not.</td>
<td>I have evaluated my method by listing errors.</td>
<td>I have stated how I suggest improvement to my procedures.</td>
</tr>
<tr>
<td><strong>3-4</strong></td>
<td>I have presented the data I collected in my experiment by using the correct type of graph, including titles, axis labels.</td>
<td>I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis by stating if it has been supported or not, based on my data.</td>
<td>I have evaluated my method by listing errors in my procedures and lab work.</td>
<td>I have stated how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td><strong>5-6</strong></td>
<td>I have organized the data I collected in my experiment using tables that include units in the proper place.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have given an account of how and why the variables are related.</td>
<td>I have evaluated my hypothesis by briefly mentioning the data to state if my hypothesis has been supported or not, based on my data.</td>
<td>I have evaluated my method by briefly considering my procedures and lab work.</td>
<td>I have stated how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td><strong>7-8</strong></td>
<td>I have correctly organized the data I collected in my experiment using tables that include units in the proper place. I have processed my data using proper methods and showed examples. My graph is correct, including titles, axis labels, and I have used lines of best fit.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have correctly given an account of how and why the variables are related.</td>
<td>I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.</td>
<td>I have evaluated my method by considering the strengths and limitations of my methods and addressed its significance.</td>
<td>I have provided details of how I suggest improvement to limitations in my procedures.</td>
</tr>
</tbody>
</table>

Created by Brian Neises 2014. Acknowledgements on last page.
## Criterion B: Inquiring & Designing

**i.** explain a problem or question to be tested by a scientific investigation  
**ii.** formulate a testable hypothesis and explain it using scientific reasoning  
**iii.** explain how to manipulate the variables, and explain how data will be collected  
**iv.** design scientific investigations

<table>
<thead>
<tr>
<th>Level</th>
<th>The student is able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>i. <strong>state</strong> a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>outline</strong> a testable hypothesis</td>
</tr>
<tr>
<td></td>
<td>iii. <strong>outline</strong> the variables</td>
</tr>
<tr>
<td></td>
<td>iv. <strong>design</strong> a method, with limited success</td>
</tr>
<tr>
<td>3-4</td>
<td>i. <strong>outline</strong> a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>formulate</strong> a testable hypothesis <strong>using scientific reasoning</strong></td>
</tr>
<tr>
<td></td>
<td>iii. <strong>outline</strong> how to manipulate the variables, and <strong>outline</strong> how relevant data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a <strong>safe</strong> method in which he or she selects materials and equipment</td>
</tr>
<tr>
<td>5-6</td>
<td>i. <strong>describe</strong> a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>formulate and explain</strong> a testable hypothesis <strong>using scientific reasoning</strong></td>
</tr>
<tr>
<td></td>
<td>iii. <strong>describe</strong> how to manipulate the variables, and <strong>describe</strong> how sufficient, relevant data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a <strong>complete and safe</strong> method in which he or she selects appropriate materials and equipment</td>
</tr>
<tr>
<td>7-8</td>
<td>i. <strong>explain</strong> a problem or question to be tested by a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>formulate and explain</strong> a testable hypothesis <strong>using correct scientific reasoning</strong></td>
</tr>
<tr>
<td></td>
<td>iii. <strong>explain</strong> how to manipulate the variables, and <strong>explain</strong> how sufficient, relevant data will be collected</td>
</tr>
<tr>
<td></td>
<td>iv. design a <strong>logical, complete and safe</strong> method in which he or she selects appropriate materials and equipment</td>
</tr>
</tbody>
</table>

## Criterion C: Processing & Evaluating

**i.** present collected and transformed data  
**ii.** interpret data and explain results using scientific reasoning  
**iii.** evaluate the validity of a hypothesis based on the outcome of the scientific investigation  
**iv.** evaluate the validity of the method  
**v.** explain improvements or extensions to the method

<table>
<thead>
<tr>
<th>Level</th>
<th>The student is able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>i. <strong>collect and present</strong> data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>accurately interpret</strong> data</td>
</tr>
<tr>
<td></td>
<td>iii. <strong>state</strong> the validity of a hypothesis based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>iv. <strong>state</strong> the validity of the method based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>v. <strong>state</strong> improvements or extensions to the method</td>
</tr>
<tr>
<td>3-4</td>
<td>i. <strong>correctly collect and present</strong> data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>accurately interpret</strong> data and <strong>explain</strong> results</td>
</tr>
<tr>
<td></td>
<td>iii. <strong>outline</strong> the validity of a hypothesis based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>iv. <strong>outline</strong> the validity of the method based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>v. <strong>outline</strong> improvements or extensions to the method that would benefit the scientific investigation</td>
</tr>
<tr>
<td>5-6</td>
<td>i. <strong>correctly collect, organize and present</strong> data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>accurately interpret</strong> data and <strong>explain</strong> results <strong>using scientific reasoning</strong></td>
</tr>
<tr>
<td></td>
<td>iii. <strong>discuss</strong> the validity of a hypothesis based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>iv. <strong>discuss</strong> the validity of the method based on the outcome of a scientific investigation</td>
</tr>
<tr>
<td></td>
<td>v. <strong>describe</strong> improvements or extensions to the method that would benefit the scientific investigation</td>
</tr>
<tr>
<td>7-8</td>
<td>i. <strong>correctly collect, organize, transform and present</strong> data in numerical and/or visual forms</td>
</tr>
<tr>
<td></td>
<td>ii. <strong>accurately interpret</strong> data and <strong>explain</strong> results <strong>using correct scientific reasoning</strong></td>
</tr>
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<td></td>
<td>iii. <strong>evaluate</strong> the validity of a hypothesis based on the outcome of a scientific investigation</td>
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<tr>
<td></td>
<td>v. <strong>explain</strong> improvements or extensions to the method that would benefit the scientific investigation</td>
</tr>
</tbody>
</table>
### Task Specific Clarifications

**MYP Lab Report**

<table>
<thead>
<tr>
<th>B</th>
<th>i. Explain a problem or question to be tested by a scientific investigation</th>
<th>ii. Formulate a testable hypothesis and explain it using scientific reasoning</th>
<th>iii. Explain how to manipulate the variables, and explain how data will be collected</th>
<th>iv. Design scientific investigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>I have stated a problem as a research question that connects with our topic.</td>
<td>My hypothesis is testable.</td>
<td>I have given brief details on the variables.</td>
<td>I have a procedure written down for my lab.</td>
</tr>
<tr>
<td>3-4</td>
<td>I have given brief details on how my problem is connected to the topic we are studying. I have stated the problem as a research question.</td>
<td>My hypothesis is testable, and includes my variables.</td>
<td>I have given brief details on how to manipulate the independent variable, how to measure the dependent variable to collect relevant data, and how to manipulate the controlled variables.</td>
<td>My procedures are safe. I have selected the materials I will need.</td>
</tr>
<tr>
<td>5-6</td>
<td>I have provided details on a problem I want to investigate, and how it is connected to the topic we are studying. I have stated the problem as a research question that includes my variables.</td>
<td>My hypothesis is testable and I provided details about my variables using words like 'increase, decrease, no change', and I have supported it clearly using scientific reasoning in my 'because' statement.</td>
<td>I have provided details on how to manipulate the independent variable, how to measure the dependent variable to collect sufficient relevant data, and how to manipulate all the controlled variables.</td>
<td>My procedures are safe and complete. Someone else could probably do my lab because I describe how to collect data. I have selected the materials I will need, including quantities.</td>
</tr>
<tr>
<td>7-8</td>
<td>I have given a detailed account of a problem I want to investigate using scientific facts and sources, and how it is connected to the topic we are studying. I have stated the problem as a research question that includes my variables.</td>
<td>My hypothesis is testable and I provide details about my variables using words like 'increase, decrease, no change', and I have supported it clearly using correct scientific reasoning in my 'because' statement.</td>
<td>I have given a detailed account of how to manipulate the independent variable, how to measure the dependent variable to collect sufficient relevant data, and how to manipulate all the controlled variables.</td>
<td>My procedures are safe, complete, and logical. Someone else would have no problem with my lab because I describe how to work with the variables and collect data. I have selected every material I will need, including quantities, and I won't need to ask for anything on the day of the lab.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>i. Present collected and transformed data</th>
<th>ii. Interpret data and explain results using scientific reasoning</th>
<th>iii. Evaluate the validity of a hypothesis based on the outcome of an investigation</th>
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<th>v. Explain improvements or extensions to the method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>I have presented the data I collected in my experiment using tables or graphs.</td>
<td>I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.</td>
<td>I have evaluated my hypothesis by stating if it has been supported or not, based on my data.</td>
<td>I have evaluated my method by listing errors in my procedures and lab work.</td>
<td>I have stated how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td>3-4</td>
<td>I have presented the data I collected in my experiment by using the correct type of graph, including titles, axis labels.</td>
<td>I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have given an account of how and why the variables are related.</td>
<td>I have evaluated my hypothesis by briefly mentioning the data to state if my hypothesis has been supported or not, based on my data.</td>
<td>I have evaluated my method by briefly considering my procedures and lab work.</td>
<td>I have given brief details of how I suggest improvement to limitations in my procedures.</td>
</tr>
<tr>
<td>5-6</td>
<td>I have organized the data I collected in my experiment using tables that include units in the proper place. My graph is the correct type, including titles, axis labels, and I have used lines of best fit.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have given a detailed account of how and why the variables are related.</td>
<td>I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.</td>
<td>I have evaluated my method by considering the strengths and limitations of my procedures and lab work. I have discussed the validity and reliability of my methods, and addressed its significance.</td>
<td>I have provided details of how I suggest improvement to limitations in my procedures. These suggestions are realistic and based on scientific reasoning and research.</td>
</tr>
<tr>
<td>7-8</td>
<td>I have correctly organized the data I collected in my experiment using tables that include units in the proper place. I have processed my data using proper methods and showed examples. My graph is correct, including titles, axis labels, and I have used lines of best fit.</td>
<td>I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have correctly given a detailed account of how and why the variables are related.</td>
<td>I have evaluated my hypothesis by weighing up the strengths and limitations of the data I collected, and have used the data to clearly state if my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.</td>
<td>I have evaluated my method by weighing up the strengths and limitations of my procedures and lab work. I have specifically discussed the validity and reliability of my methods in the table and addressed its significance.</td>
<td>I have given a detailed account of how I suggest improvements to specific limitations in my procedures. These suggestions are realistic and based on scientific reasoning and research.</td>
</tr>
</tbody>
</table>
How do I use this guide?

Supporting The Scientific Method

WITH STUDENTS
I always print out a paper copy and give it to the students at the beginning of each year (pages 1–12, plus the grade specific rubrics). I also post a digital copy for students to access all year. We go back to the guide over and over when working on labs.

In MYP 1 I print out the lab report template page by page, and on the reverse side I copy the section we are focusing on (variables, pattern, improvements, etc).

In MYP 2–3, I give students a digital template to work from. In MYP 4–5, word process themselves and can tweak the format to suit their labs.

RATIONALE
This guide is based on the assumption that there is no reason all DP students cannot earn full marks on their labs. As MYP teachers it’s our job to make sure they enter the DP ready to go! That means more focus on skills, less on cramming content. It takes a long time in MYP 1, but by MYP 5 they are writing labs that would have put me to shame in university!

PRINTING
The pages that follow are designed to be copied to the back of a lab report template. The idea being that if you are focusing on hypotheses, then you could hand out the first page of the lab report template with only the hypothesis section copied to the back.

Works Cited

Inquiring Variables (B.iii)

Variables are the part of your experiment that you will change and measure. Choosing appropriate variables will also help you make it a fair test. In a scientific inquiry you will change only one type of thing, and only measure one type of thing. The rest of the things you could change, you must actually keep the same!

**Independent variable**
- the variable you decide to change
- always choose a range based on research
- make sure to include appropriate labels

**Dependent variable**
- what you will measure
- make sure it is able to be measured using numbers!

**Controlled variables**
- all the things you will keep the same
- make sure you describe what they should be, and how you will make sure they stay that way!
Defining the Problem (B.i)

When you put your independent and dependent variables together, you can form a question that you will try to answer through your experiment. Your research question is what you are trying to answer when you write your conclusion or form your hypothesis. You must also explain why this is a problem that needs to be tested.

Research Question is Testable

• this means it can be measured
• what units will you measure with?

You don’t already know the answer

• if you already know the answer, don’t waste your time experimenting!
• if you can easily find the answer on google, then maybe it’s not the best experiment

Does not try to test too much

• it is not too large of an experiment that will take longer than you have to test, and write up your report

Includes the independent and dependent variables

• you can write your question in form: How does the (independent variable) affect the (dependent variable)?

Includes an explanation

• explain how this is related to the topic being studied
• explain why it is a relevant question or problem
• includes scientific evidence or data from your research
Inquiring Hypothesis (B.ii)

Your hypothesis is a statement you make BEFORE you do your experiment, that describes what you think will happen. Our hypotheses are often wrong, and that’s ok! After your experiment you will see if your data supports or contradicts your hypothesis.

**Prediction**
- what you think will happen
- refers to the independent and dependent variables

**Evidence**
- a description of why you made your prediction
- you should use sources such as books, magazines, the internet, or other lab reports and experiments
- make sure to cite your sources!

**Format**
- written in a format like: “If I (increase/decrease) my (independent variable), the (dependent variable) will (increase/decrease), because (reasons with information and citation of sources).”
Designing Procedure (B.iv)

Your procedure is a very detailed description of what you PLAN to do, not a record of what you changed. If you change anything, you can discuss it in your EVALUATION. Make sure to write a procedure that not just you understand, but that is good enough that someone from another school could do your experiment exactly the way you did!

Clear and easy to follow
• use proper vocabulary
• use the variables in your procedure
• use the quantities in your materials list
• use a numbered list to help others know the steps and the order
• have someone proof read your instructions and see if it makes sense to them

Controlled variables
• make sure you describe how you will make sure they stay the same as part of your procedure!

Data
• include how you will collect your data
• more data is better! don’t just test once, why not 3, 5, 10, or 20 times?
Designing Materials (B.iv)

The materials you need for your lab are very important. Many students forget to ask for proper materials, and then cannot complete their lab. It is important that you think through what you will need, and specifically ask for it before the lab is supposed to start.

Materials Request
- if you do not make a request in enough time, you may not be able to get the materials you need for your lab
- if you’re not sure we have something...ask!

Be Specific!
- you get what you ask for!
- someone else should be able to read your list and go get you everything you need, if they can’t, then you weren’t specific enough!

Quantity
- don’t ask for “water” or a “beaker”, but “250ml of water” or a “500ml beaker”
- not “salt” but “10g of salt”
Collecting Raw Data (C.i)

Raw data is data that you collect in the experiment. Usually we use a table to collect the data if it is measured. It is also possible to write our observations as sentences, or to take pictures or video for further evidence.

Do it before the experiment
• don’t wait until you start the experiment to figure out how to record your data, do it as part of the plan before you start

Can it be messy?
• as long as you can read it!
• you’ll be doing a final version in your lab report

Where do the variables go?
• independent on the LEFT
• dependent on the RIGHT

No labels in the tables
• DO NOT include labels in the table, only include them in the title boxes!

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>Temp #1 (°C)</th>
<th>Temp #2 (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>60</td>
<td>17</td>
<td>16</td>
</tr>
</tbody>
</table>
Process
Data Processing (C.i)

After you have completed your experiment you will need to process your raw data. Do you need to find the mean, median, or mode? Maybe a percentage, total, or difference is best? How about a t-test? It will depend on your data!

No averages!
- find the mean, median, or mode not the average!
- you may need to find more than one depending on your data

Show your work
- include the formulas used
- include one example of your processed data for each different type of formula you used

Explain in words
- include a few written sentences to explain why you chose the formula you did
- don’t just say, “because I have to process my data”!
**Process**

**Processed Data Table (C.i)**

After you have processed your data, you need to present it in a second table. This will be the table that you use to make your graph, and your conclusion.

<table>
<thead>
<tr>
<th>New table</th>
<th>Smaller table</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>• create a second table after your data</td>
<td>• yes, it is going to be smaller than the raw</td>
<td>• independent variable in the left</td>
</tr>
<tr>
<td>processing section</td>
<td>data table!</td>
<td>column</td>
</tr>
<tr>
<td>• DO NOT just add a section on to your raw</td>
<td>• do not include all the raw data in the new</td>
<td>• dependent variable in the right</td>
</tr>
<tr>
<td>data table, it should be a separate table</td>
<td>table, just the processed data</td>
<td>column(s)</td>
</tr>
</tbody>
</table>

**Processed Data Table (C.i)**

After you have processed your data, you need to present it in a second table. This will be the table that you use to make your graph, and your conclusion.
Process
Graphing (C.i)

Use your processed data to create a graph that shows the results of your experiment. It should be neat, including proper titles, and must be the proper type of graph!

Type of graph
• depends on the type of data your independent variable produces
• continuous data = line graph or scatter plot
• discreet data = bar or pie chart

Don't forget to include...
• title
• x and y axis
• axis titles including units
• proper scale of numbers

Computer or hand drawn?
• both are fine, but the computer doesn’t always make good science graphs, sometimes it is quicker and easier to draw them by hand
• hand drawn graphs need to be neat!

Continuous data
• data that could be any number on a continuum
• starts, changes, stops
• changes over time are usually continuous
• imagine the slope of a hill

Discreet data
• data that has only certain options
• imagine a set of steps
• number of people, shoe size, type of exercise are all types of discreet data
• whenever you create groups you create discreet data, i.e. - 0-5minutes, 6-10minutes, 11-15minutes are discreet groups even though time is usually continuous
• if you want to compare different groups, or show which group is the largest, then a vertical line diagram is best
• if you want to compare parts of a whole, then a pie chart is best
Process Patterns (C.ii)

Before evaluating your hypothesis you need to first identify the patterns in the data. Is the dependent variable increasing or decreasing? Is there a linear relationship, or exponential? How exactly are the variables related or not related?

<table>
<thead>
<tr>
<th>Increase, decrease, or constant</th>
<th>Relationships between variables</th>
<th>Common graph types</th>
</tr>
</thead>
<tbody>
<tr>
<td>• data does not go “up”, it increases</td>
<td>• direct = both increase, or both decrease</td>
<td>• is this a linear relationship, can you represent it with a line of best fit?</td>
</tr>
<tr>
<td>• data does not go “down”, it decreases</td>
<td>• indirect = they are opposite</td>
<td>• is this an exponential relationship?</td>
</tr>
<tr>
<td>• data does not stay the same, it is constant</td>
<td></td>
<td>• do you see a normal distribution?</td>
</tr>
<tr>
<td>• sometimes data does 1, 2, or all 3 of these at different points</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Evaluation

Evaluating the Hypothesis (C.iii)
When you evaluate your hypothesis, you will be discussing if it was supported or not. This should reference your data, graph, and the patterns you found. Make sure to have a very clear statement of your final conclusion.

Did you prove it?
• you cannot prove your hypothesis correct, you can only support it
• make sure to discuss the data that supports your thinking

Data, data, data
• make sure to discuss the data, actually use numbers with units to discuss your findings
• refer to the table and graph to help support your thoughts

Research
• have you found information elsewhere to support your ideas? if so, then use a proper citation
Evaluation

Evaluating the Method (C.iv)

Your method probably wasn’t perfect, that’s ok, as long as you discuss the issues. There are two types of errors in your method, the first type is reliability. Reliability according to Worthen is “The measure of how stable, dependable, trustworthy, and consistent a test is in measuring the same thing each time (1993).

The second type of error in method is validity. Worthen describes a method as being valid in “the degree to which they accomplish the purpose for which they are being used” (1993). Meaning, does your method actually measure what you are trying to measure.

Reliability of Method

Consistency

• did your method allow for a consistent set of data to be collected, or did the measurements change because of your method?
• two people measuring the same thing differently is an issue with reliability

Measuring tools

• using poor tools to measure may affect reliability
• counting out loud is not a very reliable way to measure time, a stopwatch is much more reliable

Validity of Method

Proper variables

• make sure your variables are actually the correct ones to assess what you’re trying to investigate
• if you’re interested in health, is measuring someone’s weight the most valid measurement, or would BMI be better?

Proper tools

• make sure your measurement tool is the proper way to measure your variable
• if you want to measure the change in acidity, then blue-red litmus paper will not give you a valid set of data, you may need a pH probe
Evaluation
Suggesting Improvements (C.v)

Now that you have identified areas of reliability and validity that need improvement, make sure to suggest specific ways to improve on these.

**Specific**
- your suggestions should be very specific, not “try harder” or “do more”

**Realistic**
- make sure that your suggestions are realistic
- this does not mean that you cannot suggest using equipment that we do not have though! Just don’t suggest using lightsabers!

**Research**
- you may need to do a bit of research to find suggestions. “I don’t know” is not acceptable. Find out!