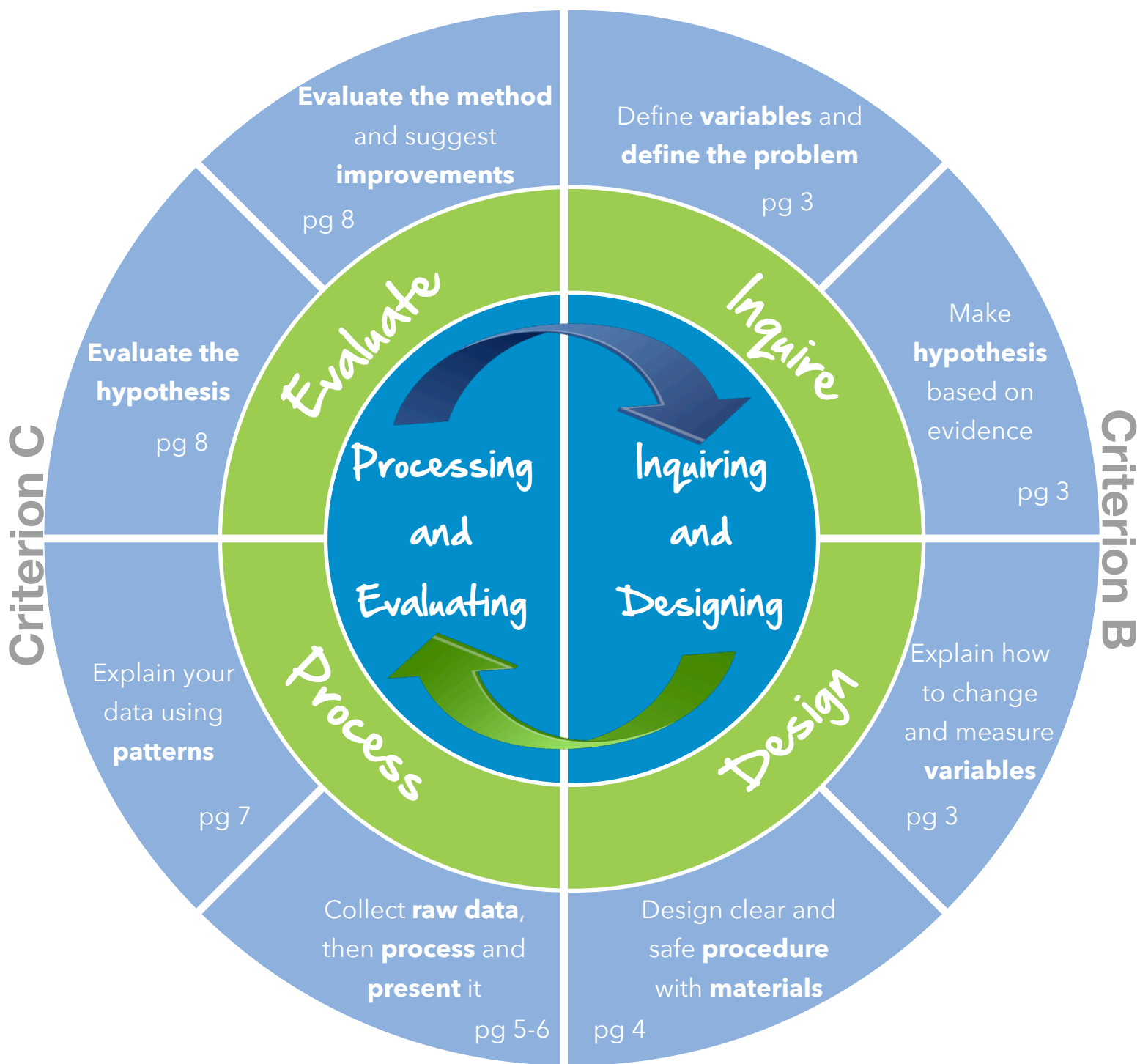


MYP SCIENCE LAB REPORT GUIDE



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

LAB REPORTGUIDE

MYP Science Aims

- cultivate analytical , inquiring and flexible minds that pose questions, solve problems, construct explanantions and judge arguments
- develop skills to design and perform investigations, evaluate evidence and reach conclusions



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

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

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!

Time (seconds)	Dependent variable!	
	Temp #1 (C)	Temp #2 (C)
0	23	23
30	20	19
60	17	16

Independent variable!

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?

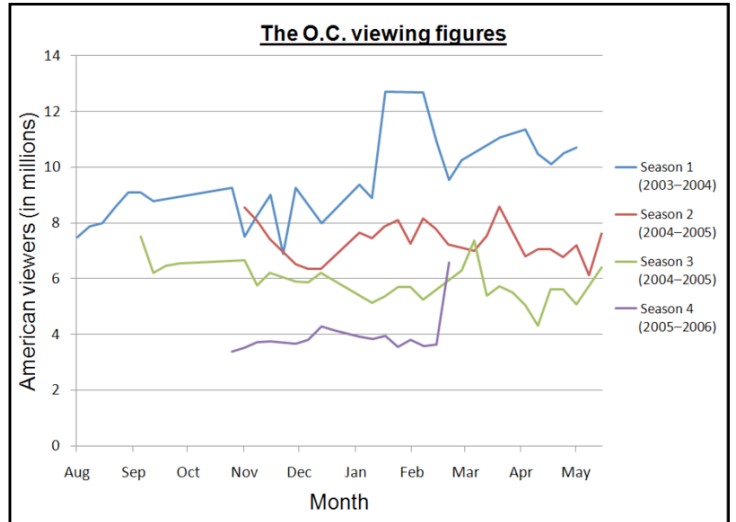
- both are fine, but the computer doesn't always make good science graphs, sometimes it is quicker and easier to draw them by hand
- hand drawn graphs need to be neat!

Continuous data

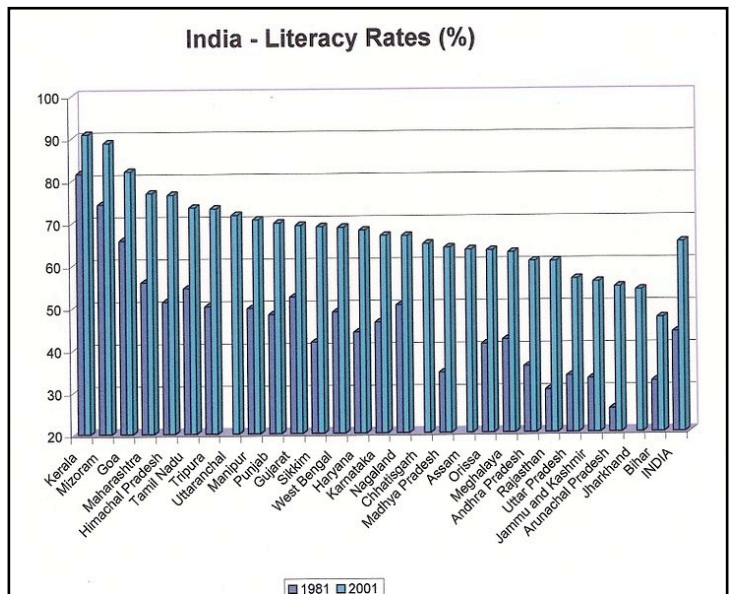
- data that could be any number on a continuum
- starts, changes, stops
- changes over time are usually continuous
- imagine the slope of a hill

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. - 0-5minutes, 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

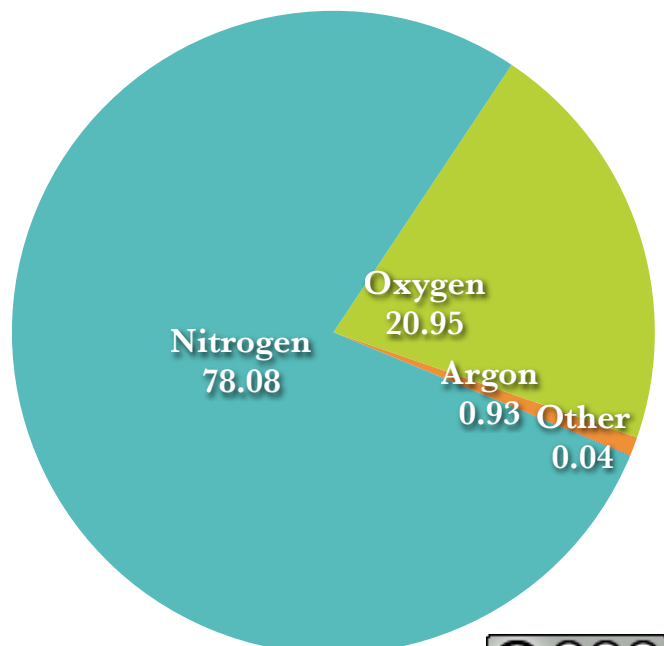


By Rambo's Revenge (Own work) [CC-BY-SA-3.0] or GFDL, via Wikimedia Commons



P.K.Niyogi at Wikipedia GFDL or CC-BY-SA-3.0, via Wikimedia Commons

Gases of the Air



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!



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



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.
3. Use common sense!
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.

MYP SCIENCE LAB REPORT

Name:
Group:

B.iii

Independent variable (x axis)		Data Range:
Dependent variable (y axis)		How will I measure this:
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

MYP SCIENCE LAB REPORT

C.iii

Evaluating the Hypothesis : Discuss your graph and data to evaluate if your hypothesis was supported or not.

C.iv

Evaluating the Method &

C.v

Suggesting Improvements: Discuss the reliability and validity of your method, and suggest improvements. (add as many points as you need)

Method	Significance (low, moderate, high)	Improvement

Criterion B: Inquiring & Designing

- i. outline an appropriate problem or research question to be tested by a scientific investigation
- ii. outline a testable prediction using scientific reasoning
- iii. outline how to manipulate the variables, and outline how data will be collected
- iv. design scientific investigations

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. select a problem or question to be tested by a scientific investigation ii. select a testable prediction iii. state a variable iv. design a method with limited success.
3-4	<ul style="list-style-type: none"> i. state a problem or question to be tested by a scientific investigation ii. state a testable prediction iii. state how to manipulate the variables, and state how data will be collected iv. design a safe method in which he or she selects materials and equipment.
5-6	<ul style="list-style-type: none"> i. state a problem or question to be tested by a scientific investigation ii. outline a testable prediction iii. outline how to manipulate the variables, and state how relevant data will be collected iv. design a complete and safe method in which he or she selects appropriate materials and equipment.
7-8	<ul style="list-style-type: none"> i. outline a problem or question to be tested by a scientific investigation ii. outline a testable prediction using scientific reasoning iii. outline how to manipulate the variables, and outline how sufficient, relevant data will be collected iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment.

Criterion C: Processing & Evaluating

- i. present collected and transformed data
- ii. interpret data and outline results using scientific reasoning
- iii. discuss the validity of a prediction based on the outcome of the scientific investigation
- iv. discuss the validity of the method
- v. describe improvements or extensions to the method

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. collect and present data in numerical and/or visual forms ii. interpret data iii. state the validity of a prediction based on the outcome of a scientific investigation, with limited success iv. state the validity of the method based on the outcome of a scientific investigation, with limited success v. state improvements or extensions to the method that would benefit the scientific investigation, with limited success.
3-4	<ul style="list-style-type: none"> i. correctly collect and present data in numerical and/or visual forms ii. accurately interpret data and outline results iii. state the validity of a prediction based on the outcome of a scientific investigation iv. state the validity of the method based on the outcome of a scientific investigation v. state improvements or extensions to the method that would benefit the scientific investigation.
5-6	<ul style="list-style-type: none"> i. correctly collect, organize and present data in numerical and/or visual forms ii. accurately interpret data and outline results using scientific reasoning iii. outline the validity of a prediction based on the outcome of a scientific investigation iv. outline the validity of the method based on the outcome of a scientific investigation v. outline improvements or extensions to the method that would benefit the scientific investigation.
7-8	<ul style="list-style-type: none"> i. correctly collect, organize, transform and present data in numerical and/or visual forms ii. accurately interpret data and outline results using correct scientific reasoning iii. discuss the validity of a prediction based on the outcome of a scientific investigation iv. discuss the validity of the method based on the outcome of a scientific investigation v. describe improvements or extensions to the method that would benefit the scientific investigation.



Task Specific Clarifications

MYP Lab Report

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

C	<i>i. present collected and transformed data</i>	<i>ii. interpret data and outline results using scientific reasoning</i>	<i>iii. discuss the prediction of a based on the outcome of the scientific investigation</i>	<i>iv. discuss the validity of the method</i>	<i>v. describe improvements or extensions to the method</i>
1-2	I have presented the data I collected in my experiment using tables or graphs .	I have attempted to recognize patterns and draw conclusions from the data.	I have evaluated my hypothesis .	I have evaluated my method .	I have stated how I suggest improvement to my procedures.
3-4	I have presented the data I collected in my experiment by using the correct type of graph , including titles, axis labels.	I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.	I have evaluated my hypothesis by stating if it has been supported or not, based on my data.	I have evaluated my method by listing errors in my procedures and lab work.	I have stated how I suggest improvement to limitations in my procedures.
5-6	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.	I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have given some details of how and the variables are related.	I have evaluated my hypothesis by briefly mentioning the data to state if I my hypothesis has been supported or not, based on my data.	I have evaluated my method by briefly considering my procedures and lab work.	I have given brief details of how I suggest improvement to limitations in my procedures.
7-8	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.	I have correctly used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have <u>correctly</u> given some details of how and the variables are related.	I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if I my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.	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.	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.



Criterion B: Inquiring & Designing

MYP 2-3

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

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. state a problem or question to be tested by a scientific investigation, with limited success ii. state a testable hypothesis iii. state the variables iv. design a method, with limited success
3-4	<ul style="list-style-type: none"> i. state a problem or question to be tested by a scientific investigation ii. outline a testable hypothesis using scientific reasoning iii. outline how to manipulate the variables, and state how relevant data will be collected iv. design a safe method in which he or she selects materials and equipment
5-6	<ul style="list-style-type: none"> i. outline a problem or question to be tested by a scientific investigation ii. outline and explain a testable hypothesis using scientific reasoning iii. outline how to manipulate the variables, and outline how sufficient, relevant data will be collected iv. design a complete and safe method in which he or she selects appropriate materials and equipment
7-8	<ul style="list-style-type: none"> i. describe a problem or question to be tested by a scientific investigation ii. outline and explain a testable hypothesis using correct scientific reasoning iii. describe how to manipulate the variables, and describe how sufficient, relevant data will be collected iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment.

Criterion C: Processing & Evaluating

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

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. collect and present data in numerical and/or visual forms ii. accurately interpret data iii. state the validity of a hypothesis with limited reference to a scientific investigation iv. state the validity of the method with limited reference to a scientific investigation v. state limited improvements or extensions to the method
3-4	<ul style="list-style-type: none"> i. correctly collect and present data in numerical and/or visual forms ii. accurately interpret data and describe results iii. state the validity of a hypothesis based on the outcome of a scientific investigation iv. state the validity of the method based on the outcome of a scientific investigation v. state improvements or extensions to the method that would benefit the scientific investigation
5-6	<ul style="list-style-type: none"> i. correctly collect, organize and present data in numerical and/or visual forms ii. accurately interpret data and describe results using scientific reasoning iii. outline the validity of a hypothesis based on the outcome of a scientific investigation iv. outline the validity of the method based on the outcome of a scientific investigation v. outline improvements or extensions to the method that would benefit the scientific investigation
7-8	<ul style="list-style-type: none"> i. correctly collect, organize, transform and present data in numerical and/or visual forms ii. accurately interpret data and describe results using correct scientific reasoning iii. discuss the validity of a hypothesis based on the outcome of a scientific investigation iv. discuss the validity of the method based on the outcome of a scientific investigation v. describe improvements or extensions to the method that would benefit the scientific investigation.



Task Specific Clarifications

MYP Lab Report

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

C	<i>i. present collected and transformed data</i>	<i>ii. interpret data and describe results using scientific reasoning</i>	<i>iii. discuss the validity of a hypothesis based on the outcome of the scientific investigation</i>	<i>iv. discuss the validity of the method</i>	<i>v. describe improvements or extensions to the method</i>
1-2	I have presented the data I collected in my experiment using tables or graphs .	I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.	I have evaluated my hypothesis by stating if it has been supported or not.	I have evaluated my method by listing errors.	I have stated how I suggest improvement to my procedures.
3-4	I have presented the data I collected in my experiment by using the correct type of graph , including titles, axis labels.	I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data. I have given an account of the variables.	I have evaluated my hypothesis by stating if it has been supported or not, based on my data.	I have evaluated my method by listing errors in my procedures and lab work.	I have stated how I suggest improvement to limitations in my procedures.
5-6	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.	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.	I have evaluated my hypothesis by briefly mentioning the data to state if I my hypothesis has been supported or not, based on my data.	I have evaluated my method by briefly considering my procedures and lab work.	I have given brief details of how I suggest improvement to limitations in my procedures.
7-8	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.	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.	I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if I my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.	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.	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.



Criterion B: Inquiring & Designing

MYP 4-5

- 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

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. state a problem or question to be tested by a scientific investigation ii. outline a testable hypothesis iii. outline the variables iv. design a method, with limited success
3-4	<ul style="list-style-type: none"> i. outline a problem or question to be tested by a scientific investigation ii. formulate a testable hypothesis using scientific reasoning iii. outline how to manipulate the variables, and outline how relevant data will be collected iv. design a safe method in which he or she selects materials and equipment
5-6	<ul style="list-style-type: none"> i. describe a problem or question to be tested by a scientific investigation ii. formulate and explain a testable hypothesis using scientific reasoning iii. describe how to manipulate the variables, and describe how sufficient, relevant data will be collected iv. design a complete and safe method in which he or she selects appropriate materials and equipment
7-8	<ul style="list-style-type: none"> i. explain a problem or question to be tested by a scientific investigation ii. formulate and explain a testable hypothesis using correct scientific reasoning iii. explain how to manipulate the variables, and explain how sufficient, relevant data will be collected iv. design a logical, complete and safe method in which he or she selects appropriate materials and equipment

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

Level	The student is able to:
1-2	<ul style="list-style-type: none"> i. collect and present data in numerical and/or visual forms ii. accurately interpret data iii. state the validity of a hypothesis based on the outcome of a scientific investigation iv. state the validity of the method based on the outcome of a scientific investigation v. state improvements or extensions to the method
3-4	<ul style="list-style-type: none"> i. correctly collect and present data in numerical and/or visual forms ii. accurately interpret data and explain results iii. outline the validity of a hypothesis based on the outcome of a scientific investigation iv. outline the validity of the method based on the outcome of a scientific investigation v. outline improvements or extensions to the method that would benefit the scientific investigation
5-6	<ul style="list-style-type: none"> i. correctly collect, organize and present data in numerical and/or visual forms ii. accurately interpret data and explain results using scientific reasoning iii. discuss the validity of a hypothesis based on the outcome of a scientific investigation iv. discuss the validity of the method based on the outcome of a scientific investigation v. describe improvements or extensions to the method that would benefit the scientific investigation
7-8	<ul style="list-style-type: none"> i. correctly collect, organize, transform and present data in numerical and/or visual forms ii. accurately interpret data and explain results using correct scientific reasoning iii. evaluate the validity of a hypothesis based on the outcome of a scientific investigation iv. evaluate the validity of the method based on the outcome of a scientific investigation v. explain improvements or extensions to the method that would benefit the scientific investigation



Task Specific Clarifications

MYP Lab Report

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

C	<i>i. present collected and transformed data</i>	<i>ii. interpret data and explain results using scientific reasoning</i>	<i>iii. evaluate the validity of a hypothesis based on the outcome of an investigation</i>	<i>iv. evaluate the validity of the method</i>	<i>v. explain improvements or extensions to the method</i>
1-2	I have presented the data I collected in my experiment using tables or graphs .	I have used knowledge and understanding of science to recognize patterns and draw conclusions from the data.	I have evaluated my hypothesis by stating if it has been supported or not, based on my data.	I have evaluated my method by listing errors in my procedures and lab work.	I have stated how I suggest improvement to limitations in my procedures.
3-4	I have presented the data I collected in my experiment by using the correct type of graph , including titles, axis labels.	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.	I have evaluated my hypothesis by briefly mentioning the data to state if I my hypothesis has been supported or not, based on my data.	I have evaluated my method by briefly considering my procedures and lab work.	I have given brief details of how I suggest improvement to limitations in my procedures.
5-6	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.	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.	I have evaluated my hypothesis by considering many possibilities. I have used the data to clearly state if I my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.	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.	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.
7-8	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.	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.	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 I my hypothesis has been supported or not. I use scientific reasons and sources to help explain my reasons.	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.	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.



END OF GUIDE



TEACHERGUIDE

Thank you to the following MYP teachers who have helped this guide evolve over the years.

- Park Eason
- Chris Briner
- Elizabeth Lee
- Stephen Taylor



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

IBO. (2014). Middle Years Programme. Sciences Guide. Cardiff.

Worthen, B. R., Borg, W. R., and White, K. R. (1993). Measurement and evaluation in the school. NY: Longman.

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!

Inquiring

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"

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!

Time (seconds)	Dependent variable!	
	Temp #1 (C)	Temp #2 (C)
0	23	23
30	20	19
60	17	16

Independent variable! (with arrow pointing to the 'Time (seconds)' column)



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.

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?

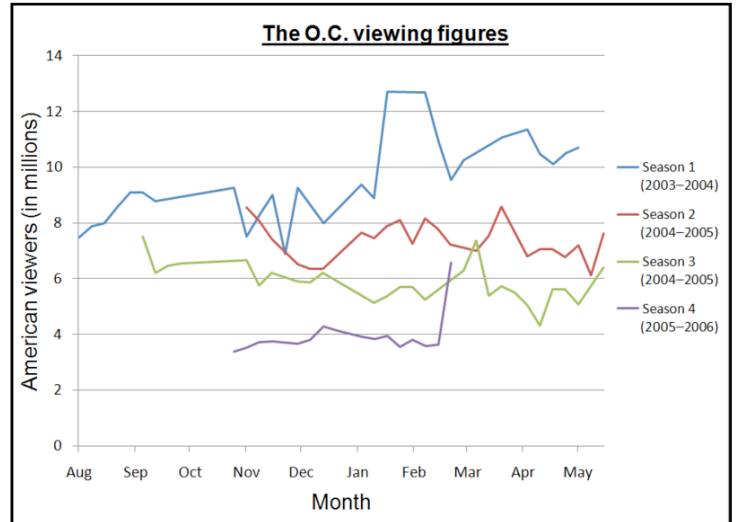
- both are fine, but the computer doesn't always make good science graphs, sometimes it is quicker and easier to draw them by hand
- hand drawn graphs need to be neat!

Continuous data

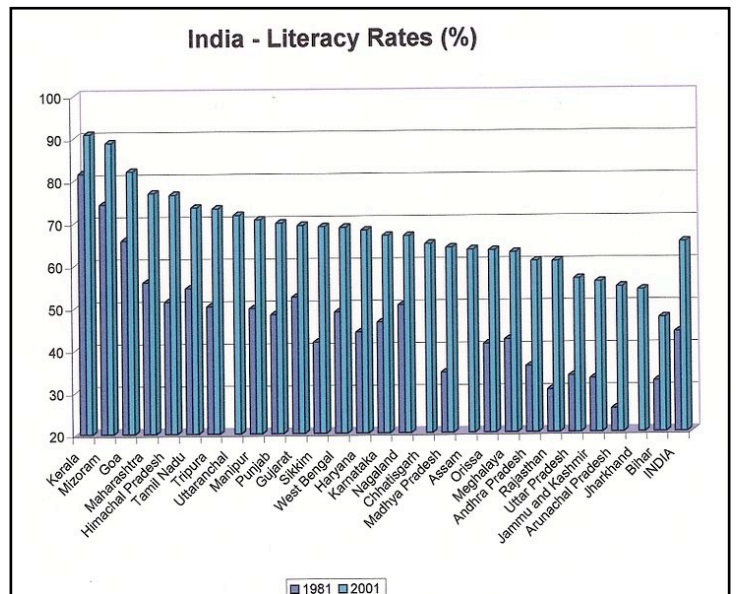
- data that could be any number on a continuum
- starts, changes, stops
- changes over time are usually continuous
- imagine the slope of a hill

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. - 0-5minutes, 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

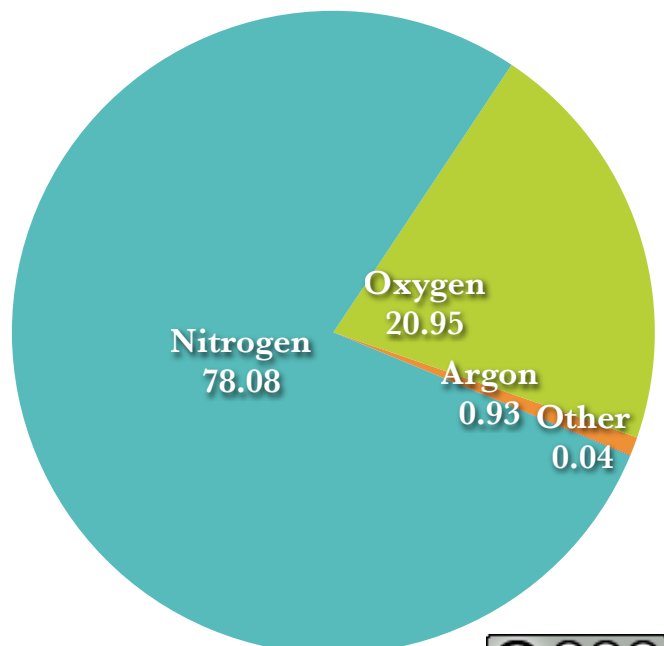


By Rambo's Revenge (Own work) [CC-BY-SA-3.0] or GFDL, via Wikimedia Commons



P.K.Niyogi at Wikipedia GFDL or CC-BY-SA-3.0, via Wikimedia Commons

Gases of the Air



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

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!