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!

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.
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!

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
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

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. Use common sense!

Lab Safety Procedures!
Attitudes in Science