***Design*** – indicates the **criteria** being assessed (please use these as **major** headings too).

 – indicates the **aspect** of the criteria being assessed

Aspect 5:

**Title** – indicates **minor** **headings** which should appear in your lab report

* – indicates **requirement** in the report

***Design***

Aspect 1: Defining the problem and selecting variables

* Report has a title which clearly reflects what is being done in this experiment; center title

**Research question**

* Research question includes IV and DV [this does not have to be in question form]
* A focused problem or a specific research question is identified and described in enough detail for the reader to understand the aim of the experiment.
* Include brief description of mechanism, or why you think IV will affect DV. This may include some “background.”
* Make prediction (ie. hypothesis; not necessary when measuring known value.)
* Make a sketch graph of predicted results; this helps improve your design [label axes with units but specific data not required.]

**Variables** *[a table is by far the best way to do this – see exemplar]*

* DV identified; quantitative
* IV identified; quantitative
* CV identified and relevant; need three (not trivial)
* Variables must be described sufficiently to permit replication (copying) of this experiment.

Aspect 2: Controlling variables

Method for controlling variables *[…NOT precision! this is “how to keep conditions uniform…”]*

* Describe how DV will be manipulated & controlled *[optional - level of the precision; sig digs]*
* Describe how IV will be manipulated & controlled *[optional - level of the precision; sig digs]*
* Described how the CVs are maintained at constant values; (*if known*, identify sig digs).

**Materials**

* List material in order of significance; most important first
* Instrument description must include the precision of the instrument
* Indicate all apparatus & materials, include volumes of tubes and cylinders, concentrations of solutions, model and manufacturer of complex apparatus; you may omit apparatus which is regarded as commonly available like “pencil” and “computer”

***Photograph*** *(or diagram)* ***[optional] of complex apparatus***

* Annotate this diagram to show how variables were involved – especially controlled variables. Do not just label the equipment. Additional diagrams are ok.

**Procedure**

* Procedure in numbered steps (or paragraphs)

Aspect 3: Developing a method for data collection

* Independent variable is tested at minimum 5 increments (or intervals or “levels”) unless you are comparing two populations (and will do statistics like the t-test)
* An adequately broad data range is considered.
* Minimum 5 trials per IV increment; however if you plan to do statistical analysis of the data - mean, standard deviation, t-test, etc. - you will need minimum 15 trials per IV increment or per population if you are comparing two populations with a t-test, for example.
* The data gathered enables the research question to be adequately addressed.
* State how the results will be presented, with reason (“this data will be put into a bar graph to show comparison” or “graphed as pie graph to show the proportion…” etc.) *The goal here is to help you imagine the end result so your plan agrees with your goal.*
* Name any statistical tests to be used, with reasons; ie. at least calculate means.
* Method is described thoroughly and is clearly understandable to the reader.
* Procedure addresses salient issues (may omit trivial steps like “record data”)
* Procedure addresses “**risk assessment**” (realistically)

***Data collection and processing***

Aspect 1: Recording raw data

*There are many fine points to include here – but they are VERY important to get full marks!*

**Raw Data**

* Is there a clear pattern in your processed data?
* Data is collected independently.
* Data is primarily quantitative (numerical)
* Data must include qualitative observations. (This may provide inspiration in the conclusion and especially the evaluation later.)
* Raw data recorded in suitable format(s)
* *Tables follow conventions (see attached list for details)*

Aspect 2: Processing Raw Data

**Processed Data**

* Suitable manner to process the raw data is used (this may involve a mathematical processing, statistical analysis, or transforming the data into a suitable graphical representation).
* All of the raw data has been completely processed.
* Example calculations provided for substantial processing (ie. don’t need to demonstrate sum, mean or standard deviation, but linear regression – if used, for example – should be shown.
* The raw data has been processed correctly (correctly using significant digits and uncertainty values).

Aspect 2: Processing Raw Data

* *Graphs follow conventions (see attached list for details)*
* Suitable format in which to present the processed data is used.
* There are clear indicators for all calculations, tables, graphs and images, like “Figure 2”
* There are clear headings for all tables
* There are clear titles for all graphs and images, like “Figure 2”
* Any graphs have appropriate scales, labeled axes with units and accurately plotted data points with a suitable best-fit line or curve if necessary. *[Do not let Excel do this for you!]*
* All the processing stages up to the final result can be followed easily (explanations are clear where necessary).
* The final results are shown expressed to the correct number of significant figures.
* The uncertainties and errors of raw data have been taken into account and this is shown in some manner (e.g. error bars may be used, as appropriate – and labeled, e.g “error bars represent standard deviation”)

***Conclusion & evaluation***

Aspect 1: concluding

**Conclusion**

* State and discuss patterns and trends in your data
* Refer explicitly to graphs and data (ie. quote your data!)
* Comparisons, if appropriate, are made; ie. experimental groups compared to control groups.
* Data related to RQ or hypothesis; to what extent do they agree/ disagree? If hypothesis is tested, state whether the data supports the hypothesis.
* Conclusion, based on, and justified by, reasonable data interpretation is made.
* Appropriate language used: “Supports my hypothesis” NOT “proves” or “is correct”
* Associated qualitative data add value to explanations (and should be present in DCP section!)
* Compare with published data when appropriate to assess the validity of results. Error analysis is mentioned in this case.
* Sources cited appropriately

Aspect 2: Evaluating procedure

**Evaluation** *[Evaluation & Improvements can be compiled in table form]*

* Reference error bars (or STDEV) with regard to suggested reliability of results.
* Explanation of reliability of results: Measurement errors are analyzed to evaluate accuracy. Instrument errors are analyzed (including possibility of calibration errors - when appropriate) to evaluate the accuracy.
* The design and method are evaluated, including discussion of replicates and sample sizes. Precision of the study is evaluated. [Try to identify ≥ three issues]
* Was data sufficient to address RQ?
* Evaluate random biological variation, measurement & instrument errors and systematic error (problems in method) in terms of: • possible affect on data; • significance regarding weakness of limitation of the data set.
* Each error is explained thoroughly and clearly: How might each have impacted the results?
* Anomalous data explained.
* Avoid “I will measure more carefully;” focus on investigation and procedure.

Aspect 3: Improving the investigation

**Improvements**

* All improvements are based on weaknesses and limitations identified in aspect 2. [Improvements must correspond to evaluation, above]
* Modifications to the experimental technique are appropriate to correct errors mentioned.
* All proposed modifications are realistic (they are actually variables that can be controlled).
* All proposed modifications are clearly explained.

***Appendix A: Manipulative skills***

Aspect 1: Following instructions

* I follow instructions accurately, adapting to new circumstances.
* I mostly work independently, reading the instructions carefully, but seek assistance when required.

Aspect 2: Carrying out techniques

* I am competent and methodical in the use of a range of techniques and equipment

Aspect 3: Working safely

* I consistently work in a way that keeps myself and others safe in the lab

***Appendix B: Authenticity and academic integrity***

* All sources of information have been cited in-text
* All sources have been included in the correct order in the bibliography
* Citation is consistent and correct throughout (using MLA[[1]](#footnote-1), or Council of Biology Editors format[[2]](#footnote-2) (note: GSIS uses MLA in other classes).
* Work has been passed through Turnitin.com before submission and the report has been attached
* Student has shown teacher only one draft and has submitted second draft for assessment
* Teacher has only assessed final draft
* Teacher has confirmed that student’s work is their own

***Appendix C: Drawings & diagrams***

Drawings (Talbot, 19)

* Drawing includes neatly written name of owner and date of drawing
* Include title which clearly identifies subject as specifically as possible. Do not include “lab” or “assignment” in titles
* Indicate perspective in or after title such as W. M., L. S. or T. S.
* Use good quality, sharp pencil; HB or softer; no ink or colored pencil
* Draw on good quality, erasable, plain paper
* Diagram(s) fit comfortably on page; usually one diagram per page
* Drawing is large; the more details you need to include the larger you should draw
* Clear line drawings without shading
* Lines meet neatly; no “ends”
* Drawn simply showing outline of basic structures
* Draw structures proportionally
* Draw accurately and faithfully what can be seen. Never draw what you cannot see – even if you expect it to be there. Never copy from a printed image.
* State drawing magnification, or drawing scale, or actual specimen size
* Indicate by two parallel lines where you have made your measurement
* Label fully all biological features keeping labels away from the diagram and never label on the actual drawing
* Avoid crossing label lines and, if possible, arrange labels vertically; one beneath the other
* Use annotations (notes added to labels) it at all possible. In particular try to relate structure to function. [This is where you include narrative qualitative data (observations)]
* Use ruler to draw straight lines when possible
* Numbers include appropriate units
* Drawing reveals intentional, rather than incidental, organization
* Nature of all information is explicitly communicated by descriptive heading(s)

Diagrams (additional to Drawings above)

* Diagrams should be greatly simplified and should conform to a scale
* Purpose of diagram is to avoid lengthy method
* Pencil should be used for drawing and ink for labels
* Colors not normally used
* Diagrams should be drawn in two dimensional cross-section
* Liquid levels should be draw horizontal with meniscuses at the sides of the containers.

***Appendix D: Table conventions***

Table organization *[this is not a heading]*

* There are clear indicators for all calculations, tables, graphs and images, like “Figure 2”
* There are clear headings for all tables
* There are clear titles for all graphs and images
* Column & row headers identical to graph axes labels (if table is source of graph data)
* IV on left column
* uses specific terms (ie. **NaCl** instead of *salt*; **volume** instead of *amount*; **etc.**)
* tables not split between pages
* cells contains only one value
* tables arranged vertically (usually)
* tables show grid lines

Table numbers *[this is not a heading]*

* uncertainty in headers after units
* center data in columns
* align decimals
* all values in a column must me same decimal place
* uses significant figures
* mean contains one more digit than significance
* SD should have two sig figs

Table units *[this is not a heading]*

* units in column headings, not in cells
* units after "/"
* no parentheses
* use SI units - according to IB
* Variable that is measured or recorded is clearly stated (e.g. in the column heading in a table).
* Units for every variable.
* Uncertainty of measurements – based on significant digits –in the column headings.
* The same level of precision (number of decimal places) is used for all the items of a variable. *[Take care to set the ‘number’ formatting appropriately if using Excel!]*
* All sources of information have been cited in text

***Appendix E: Graph conventions***

Graphing *[this is not a heading]*

* Units for every variable.
* There are clear indicators for all calculations, tables, graphs and images, like “Figure 2”
* There are clear headings for all tables
* There are clear titles for all graphs and images
* Graph data sourced from single table
* column & row headings same as graph axes
* include simple title like "NaCl concentration vs. transmittance" Mr. Reimer likes a descriptive title, but the IB does not require that.
* I follow instructions accurately, adapting to new circumstances.
* Graph data sourced from single table
* Graph is large (whole page is ideal)
* simple scale (usually 1,2 or 5 times a multiple/power of 10) [scale does not have to start at zero]

Graphing the X-axis *[this is not a heading]*

* Graph data sourced from single table
* IV
* Labels
* Units
* uncertainty (after units, like: **mass / g / ± 0.01** )
* quantitative variable
* intervals proportional
* SI units (according to IB)

Graphing the Y-axis *[this is not a heading]*

* DV (even if it is time!)
* Labels
* Units
* uncertainty (after units, like: **mass / g / ± 0.01** )
* quantitative variable
* intervals proportional
* SI units (according to IB)

Graphing error bars *[this is not a heading]*

* Error bars on x and y axis (unless error too small to indicate–then provide footnote)
* error bars may indicate SD, data range, or uncertainty
* Graph has footnotes describing what error bars represent

***Appendix F: Language & Image conventions***

Language *[this is not a heading]*

* Spelled correctly
* Punctuation used correctly
* Difficult words explained or defined
* Fonts minimized for clarity (ie. few fonts)
* Headings used for clarity

Images *[this is not a heading]*

* must have informative title

Works Cited

Purdue OWL. "MLA Formatting and Style Guide." The Purdue OWL. Purdue U Writing Lab, 10 May 2008. Web. 06 Oct. 2009. 🡨this is example

Author's Last name, First name. "Title of Article." Title of Periodical Underlined or Italicized Date of publication, volume number and issue number if scholarly: page numbers. Name of database (such as ProQuest) underlined. Subscription service name (UMI for ProQuest articles). Subscribing library and location. Day Month Year of access <Online Provider URL address in angle brackets>

Author(s) if Given. Name of Web Page. Date of Posting/ Revision. Name of institution/organization affiliated with the site (if any). Date You Accessed the Site <electronic address or URL>.

Name of Web Page When No Author is Listed. Date of Posting/ Revision. Name of institution/organization affiliated with the site (if any). Date You Accessed the Site <electronic address or URL>.

Author(s) if Given. "Title of Specific Web Article." Title of Web Magazine or Publication the Page is a Part Of. Date of Posting/Revision. Name of institution/organization affiliated with the site (if any). Date You Accessed the Site <electronic address or URL>.

Last Name, First Name. Title of a Book With One Author, Title Underlined or Italicized, With Significant Words Capitalized. Place of Publication: Publisher, Year of Publication.

Last Name, First Name. Title of Book in a Second Edition. 2nd ed. Place of Publication: Publisher, Year of Publication.

Title of a Book Without an Author, Title Underlined or Italicized. Place of Publication: Publisher, Year of Publication.

Last Name of First Author, First Name of First Author, and Second (and third, if necessary) Author's Name in Normal Order. Title of Book With Two or Three Authors, Title Underlined or Italicized. Place of Publication: Publisher, Date.

Last Name of First Author, First Name of First Author, et al. Title of Book With More Than Three Authors, Title Underlined or Italicized. Place of Publication: Publisher, Date.

Organization Name. Title of Book With a "Corporate Author," Title Underlined or Italicized. Place of Publication: Publisher, Date.

Author(s). “Title of Article in Quotation Marks.” Title of an Edited Anthology, Underlined or Italicized. Ed. Editor’s Name(s). Place of Publication: Publisher, Year. Page numbers of the specific story or essay you're using.

 “Title of Newspaper or Magazine Article With No Author Listed, Title in Quotation Marks.” Title of Magazine or Newspaper, Underlined or Italicized Day Month Year: page numbers.

Author(s). “Title of Newspaper or Magazine Article in Quotation Marks.” Title of Magazine or Newspaper, Underlined or Italicized Day Month Year: page numbers.

Author(s). “Title of Journal Article in Quotation Marks.” Title of Professional Journal With Continuous Pagination Vol (Year): page numbers.

Author(s). “Title of Journal Article in Quotation Marks.” Title of Professional Journal With Each Issue Paginated Separately Vol.Issue Number (Year): page numbers.

**Hints to students:**Uncertainty:  When determining absolute error in instrument readings, the simplest rule is to use half of smallest measuring increment (like graduated cylinder measures to 21 mL. so you will write your measurements to "21.3 mL" and the instrument error is ± 0.5 mL

When determining slope of best fit line, find TWO best fit lines.  Find the minimum slope which goes through your "error boxes" and the maximum slope which goes through your error boxes.  Your "real" value will probably lie between these points.

1. See instructions and examples of MLA format on the web at: <http://owl.english.purdue.edu/owl/resource/747/01/> [↑](#footnote-ref-1)
2. See instructions and examples of CBE/CSE format on the web at: <http://writing.wisc.edu/Handbook/DocCBE_NameYear_Intext.html> [↑](#footnote-ref-2)