

Name: \_\_\_\_\_ Lab: \_\_\_\_\_ Date: \_\_\_\_\_

ICT: \_\_\_\_\_ Data logging (1) \_\_\_\_\_ Graph plotting software (2) \_\_\_\_\_ Spreadsheet (3) \_\_\_\_\_ Database (4) \_\_\_\_\_ Computer model/simulation (5)

| Personal Engagement |   |
|---------------------|---|
| Mark                | Descriptor  |
| 0                   | <ul style="list-style-type: none"> <li>The student's report does not reach a standard described by the descriptors below.</li> </ul>  |
| 1                   | <ul style="list-style-type: none"> <li>The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or creativity.</li> <li>The justification given for choosing the research question and/or the topic under investigation does not demonstrate personal significance, interest or curiosity.</li> <li>There is little evidence of personal input and initiative in the designing, implementation or presentation of the investigation.</li> </ul> |
| 2                   | <ul style="list-style-type: none"> <li>The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or creativity.</li> <li>The justification given for choosing the research question and/or the topic under investigation demonstrates personal significance, interest or curiosity.</li> <li>There is evidence of personal input and initiative in the designing, implementation or presentation of the investigation.</li> </ul>             |

Personal Engagement Checklist:

- ☐ Research proposal completed  
☐ Statement of personal significance, interest or curiosity  
☐ Rationale statement regarding topic goals/outcomes

| Exploration |  |
|-------------|--|
| Mark        | Descriptor   |
| 0           | <ul style="list-style-type: none"> <li>The student's report does not reach a standard described by the descriptors below.</li> </ul>   |
| 1–2         | <ul style="list-style-type: none"> <li>The topic of the investigation is identified and a research question of some relevance is stated but it is not focused.</li> <li>The background information provided for the investigation is superficial or of limited relevance and does not aid the understanding of the context of the investigation.</li> <li>The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</li> <li>The report shows evidence of limited awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation*.</li> </ul> |
| 3–4         | <ul style="list-style-type: none"> <li>The topic of the investigation is identified and a relevant but not fully focused research question is described.</li> <li>The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation.</li> <li>The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</li> <li>The report shows evidence of some awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation.*</li> </ul>                   |
| 5–6         | <ul style="list-style-type: none"> <li>The topic of the investigation is identified and a relevant and fully focused research question is clearly described.</li> <li>The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation.</li> <li>The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.</li> <li>The report shows evidence of full awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation.*</li> </ul>                 |

Exploration Checklist:

- ☐ Focused research question or problem-- may include a clear hypothesis  
☐ Introduction describes current knowledge on topic and provides clear overview of this investigation  
☐ Independent variable (I.V.) & Dependent variable is (D.V.) are identified and quantitative  
☐ Controlled variable(s) is/are identified and justified

- \_\_\_ Materials list is provided
- \_\_\_ Safety, ethical or environmental considerations are described
- \_\_\_ Method describes how the I.V. will be manipulated—should include description of sample sizes, trials & replicates
- \_\_\_ Method describes how controlled variables are held constant—needs to be clear and concise
- \_\_\_ Describe apparatus & setup and/or provides a diagram/picture with annotations—including materials specific to the investigation
- \_\_\_ If applicable, cite reference for standard collection procedure—use CBE/CSE, MLA or APA
- \_\_\_ Methods are not written in person-point-of-view
- \_\_\_ Method describes how the D.V. will be measured
- \_\_\_ Method describes how data will be collected/measured
- \_\_\_ Method provides for collection of sufficient data points (5 recommended)
- \_\_\_ Method provides for replication of data points (3-5 replicates per data point / consistent results are met)

| Analysis |   |
|----------|---|
| Mark     | Descriptor  |
| 0        | <ul style="list-style-type: none"> <li>The student's report does not reach a standard described by the descriptors below.</li> </ul>  |
| 1–2      | <ul style="list-style-type: none"> <li>The report includes insufficient relevant raw data to support a valid conclusion to the research question.</li> <li>Some basic data processing is carried out but is either too inaccurate or too insufficient to lead to a valid conclusion.</li> <li>The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis.</li> <li>The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.</li> </ul>   |
| 3–4      | <ul style="list-style-type: none"> <li>The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question.</li> <li>Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing.</li> <li>The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis.</li> <li>The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.</li> </ul>                      |
| 5–6      | <ul style="list-style-type: none"> <li>The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question.</li> <li>Appropriate and sufficient data processing is carried out with the accuracy required to enable a conclusion to the research question to be drawn that is fully consistent with the experimental data.</li> <li>The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis.</li> <li>The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.</li> </ul> |

Analysis Checklist:

- \_\_\_ all relevant raw data has been included—both quantitative & qualitative
- \_\_\_ uncertainties of measures are identified
- \_\_\_ data is collected into tables with:
  - I.V. values and trials/replicates are identified
  - Cells contain only one value
  - Values are aligned (by decimal point)
- \_\_\_ data tables contain headings—both table title and columns/rows
- \_\_\_ all measurements contain units and uncertainties (written in the column heading)-
- \_\_\_ measures and uncertainties have the same significance (same place)-
- \_\_\_ all raw data has been completely processed (e.g. calculations, graphed and statistical analyses performed)
- \_\_\_ sample calculations are present & clearly explained-
  - standard calculations need not be shown but referenced (e.g. sum, mean, & standard deviation)
- \_\_\_ calculations show propagation of uncertainty (addition/subtraction vs. multiplication/division)-
- \_\_\_ a suitable format (graphs/tables) shows the relationship between I.V. & D.V.
- \_\_\_ graphs/tables have proper titles—identifying the variables included in the table
- \_\_\_ graphs have appropriate scales, labeled axes with units & uncertainties and accurately plotted data
  - A suitable best fit line/curve with appropriate equation is present
- \_\_\_ tables/graphs have annotations describing graphical relationships
- \_\_\_ statistical analyses of error is incorporated when prompted (e.g. standard deviation, error bars, max./min. slopes)

| Evaluation |   |
|------------|---|
| Mark       | Descriptor  |
| 0          | <ul style="list-style-type: none"> <li>The student's report does not reach a standard described by the descriptors below.</li> </ul>  |
| 1–2        | <ul style="list-style-type: none"> <li>A conclusion is outlined which is not relevant to the research question or is not supported by the data presented.</li> <li>The conclusion makes superficial comparison to the accepted scientific context.</li> <li>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are outlined but are restricted to an account of the practical or procedural issues faced.</li> <li>The student has outlined very few realistic and relevant suggestions for the improvement and extension of the investigation.</li> </ul>  |
| 3–4        | <ul style="list-style-type: none"> <li>A conclusion is described which is relevant to the research question and supported by the data presented.</li> <li>A conclusion is described which makes some relevant comparison to the accepted scientific context.</li> <li>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are described and provide evidence of some awareness of the methodological issues* involved in establishing the conclusion.</li> <li>The student has described some realistic and relevant suggestions for the improvement and extension of the investigation.</li> </ul>  |
| 5–6        | <ul style="list-style-type: none"> <li>A detailed conclusion is described and justified which is entirely relevant to the research question and fully supported by the data presented.</li> <li>A conclusion is correctly described and justified through relevant comparison to the accepted scientific context.</li> <li>Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are discussed and provide evidence of a clear understanding of the methodological issues* involved in establishing the conclusion.</li> <li>The student has discussed realistic and relevant suggestions for the improvement and extension of the investigation.</li> </ul> |

Checklist:

- \_\_\_\_\_ a conclusion statement describes the relationship between IV & DV
- addresses the hypothesis or research question as being supported or refuted but not “proven”
  - data is used in describing the relationship
- \_\_\_\_\_ explain the science (biology, chemistry or physics) behind the conclusion statement
- \_\_\_\_\_ known/given values are cited and used for comparison—citations follow CBE/CSE format
- error analysis of results is performed based on known/given values
- \_\_\_\_\_ overall consideration for error—random vs. systematic
- \_\_\_\_\_ the design and method is evaluated, this includes
- addressing replicates and sample sizes
  - precision of the study is addressed
- \_\_\_\_\_ Measurement errors are analyzed to evaluate accuracy and precision of measures
- \_\_\_\_\_ instrument errors are analyzed—addressing accuracy of measures & identify random vs. systematic errors
- \_\_\_\_\_ error analyses are explained thoroughly and addresses how outcomes can be affected
- \_\_\_\_\_ improvements are based on errors and limitations previously identified
- \_\_\_\_\_ proposed modifications are appropriate to limitations and realistic

| Communication |  |
|---------------|--|
| Mark          | Descriptor   |
| 0             | The student's report does not reach a standard described by the descriptors below.   |
| 1-2           | <ul style="list-style-type: none"> <li>The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.</li> <li>The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way.</li> <li>The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information.</li> <li>There are many errors in the use of subject specific terminology and conventions*.</li> </ul>       |
| 3-4           | <ul style="list-style-type: none"> <li>The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.</li> <li>The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way.</li> <li>The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation.</li> <li>The use of subject specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.</li> </ul> |

Checklist

- \_\_\_\_\_ IA contains a title page—Title of IA, student's name & IB number, date, course name & instructor's name