GROUP 4 IA MARKSCHEME AND CHECKLIST

STUDENT NAME: _____

INVESTIGATION TITLE:

Type of investigation (check one):

- ❑ A hands-on experiment
- ❑ A field study
- ❑ A database analysis
- ❑ An analysis of a simulation or model

				Overall*
Research Design	RQ Context ____/6	Method Considerations ____/6	Description of Method ____/6	**____ /6**
Data Analysis	Communication ____/6	Uncertainty ____/6	Processing ____/6	**____ /6**
Conclusion	Conclusion ____/6	Scientific Context ____/6		**____ /6**
Evaluation	Weakness / Limitations ____/6	Improvements ____/6		**____ /6**

**Marks are awarded on a "best fit" approach based on the levels awarded for each aspect of a given criteria.*

Raw Total	
IB Equivalency	
Class Grade	

Estimated IB Grade, based on May 2025* benchmarks (check year).

Grade:	1	2	3	4	5	6	7
Mark range:	0 - 3	4 - 6	7 - 10	11 - 13	14 - 16	17 - 19	20 - 24

STUDENT DECLARATION:

I confirm that this is my own work, and this is the final version. Citations are accurate for the words and ideas of another person used in published texts, videos, and relevant media.

SIGNED: _____ DATE: _____

TEACHER DECLARATION: *(check box before signing)*

- ❑ I can authenticate that the work was performed by the student as described.

SIGNED: _____ DATE: _____

RESEARCH DESIGN

An assessment of the extent to which the student effectively communicates the methodology (purpose and practice) used to address the research question.

MARK	ASPECT		
	Research Question Context	**Methodological Considerations**	**Description of Methodology**
0	The student/s report does not reach the standard described by the descriptors below.		
1-2	The research question is **stated** without context.	Methodological considerations associated with collecting data relevant to the research question are **stated.**	The description of the methodology for collecting or selecting data **lacks the detail** to allow for the investigation to be reproduced.
3-4	The research question is **outlined** within a broad context.	Methodological considerations associated with collecting relevant and sufficient data to answer the research question are **described.**	The description of the methodology for collecting or selecting data allows for the investigation to be reproduced with **few ambiguities or omissions**.
5-6	The research question is **described** within a specific and appropriate context.	Methodological considerations associated with collecting relevant and sufficient data to answer the research question are **explained.**	The description of the methodology for collecting or selecting data allows for The investigation to be **reproduced**.

RESEARCH QUESTION CONTEXT

*A contextualized research question contains **reference to the independent (manipulated)** and **dependent (responding) variables** or two correlated variables, with a concise description of the system in which the research question is embedded, and include a background theory of direct relevance.*

Research Question

- ❏ The research question is clearly stated and precisely formulated at the beginning of the paper.
- ❏ The research question is related to our subject topics (ex: enzyme activity in Biology; chemical reaction in Chemistry, etc).
- ❏ The research question includes clear and specific manipulated and responding variables or two correlated variables.
- ❏ The research question includes the scientific name(s) of the organism (*Genus species*), if relevant.

Description of the System

- ❏ I have stated a purpose or aim for my experiment. I stated the purpose of conducting this experiment. I explained how the knowledge gained from conducting this experiment can be of use. I explored why this research question is important to investigate.
- ❏ I included background information on the topic related to this experiment. I conducted research using relevant texts and included a similar or related study (in-text citation included).
- ❏ I have identified and stated the specific independent variable and the dependent variable in my research question.
- ❏ I included the range of my independent variable and provided justification/context for my chosen range.

- ❏ I mentioned the significance/context of the dependent variable. I included how many trials I intend to measure this, and any data transformations/analysis I intend to do.
- ❏ I intend to conduct a preliminary investigation to run an initial check on the design of my experiment. I will mention this as part of my introduction or methodology to help justify the procedure I chose. (if experimental-based)
- ❏ The context includes the scientific name of the organism (*Genus species*), if relevant
- ❏ Citations relevant to the contextual information are provided

Theory of Direct Relevance

- ❏ The context includes a description of the known relationships/effects of the variables being investigated.
- ❏ There is a scientifically accurate hypothesis predicting the relationship between the variables, if relevant.
- ❏ Citations relevant to the contextual information are provided

METHODOLOGICAL CONSIDERATIONS

Methodological considerations include: 1) the selection of the methods for measuring the dependent and independent variables, 2) the selection of the databases or model and the sampling of data, 3) the decisions regarding the scope, quantity and quality of measurements (e.g. the range, interval or frequency of the independent variable, repetition and precision of measurements), 4) the identification of control variables and the choice of method of their control and 5) the recognition of any safety, ethical or environmental issues that needed to be taken into account.

Selection of Methods

- ❏ The background information about the methodological approach is well described.
- ❏ The methods for measuring the variables are justified, if relevant
- ❏ I mention the source of the protocol I used for collecting data or a similar/related study that used a similar procedure. I justify the use of this protocol.

Collecting Relevant Data

- ❏ The manipulated variables (IV) are correctly identified with units and levels
- ❏ I justify the equipment I intend to use for collecting data.
- ❏ I justified the decisions I made regarding the scope, quantity and quality of measurements (e.g. the range, interval or frequency of the independent variable, repetition and precision of measurements)
- ❏ A quantifiable responding variable(s) is correctly identified with units
- ❏ I have listed **all** the possible controlled variables. I will mention **how** I will control/monitor each variable and **why** it is important to control each variable (based on scientific principles).
- ❏ There is justification/explanation for a positive and/or negative control group, if relevant
- ❏ There are sufficient validity measures to ensure the method measures what it is intended to measure

Collecting Sufficient Data

- ❏ The number and range of levels of the manipulated variable are suitable, if relevant
- ❏ The interval or frequency of measuring the responding variable is suitable if relevant
- ❏ The sample size is appropriate for the investigation and allows for statistical analysis, if relevant
- ❏ The number of repeats of the responding variable (DV) measurements is suitable to ensure reliability and allow for statistical analysis
- ❏ The precision of measurements of variables is suitable for the investigation and allows for statistical analysis

Safety, Ethics, and Environmental Considerations

- ❏ I will mention the risk assessment evaluation and recommendations on safety precautions needed in handling any chemicals and/or equipment I intend to use to collect data (if experimental-based). - Safety

- ❏ I will mention how I intend to be mindful of the resources I will use for this experiment, how I will safely dispose of any chemicals safely, and the impact of any chemicals or equipment I will use on the environment. (if experimental-based) - Environmental
- ❏ If I am collecting data from human test subjects, I will mention that consent forms will be required from any participant or ethical considerations related to privacy and access to data (especially if databased). - Ethical
- ❏ There is adherence to the IBO animal experimentation policy, if relevant
- ❏ The environmental impact of the investigation is fully considered (such as disposal of chemicals)
- ❏ There is a description and justification of approaches used to minimize the impact of the investigation on field sites

DESCRIPTION OF METHODOLOGY

The description of the methodology refers to presenting sufficiently detailed information (such as specific materials used and precise procedural steps) while avoiding unnecessary or repetitive information, so that the reader may readily understand how the methodology was implemented and could in principle repeat the investigation.

Method for Collecting/Selecting Data

- ❏ There is a list or photograph of apparatus and materials used in the investigation, including size, graduation, and uncertainty.
- ❏ There is a clear description of preliminary trials, if completed
- ❏ I describe a method that enables the collection of sufficient, relevant data. I did this by explaining how the independent variable is manipulated (changed) and how my dependent variable will be measured.
- ❏ My procedure is listed as a clear, numbered sequence of steps. The procedure is detailed enough so that it allows someone else to experiment exactly the same way I did it.
- ❏ I describe the kind of data that will be collected (Quantitative and Qualitative).
- ❏ I describe all the apparatus and materials used, including the volumes of tubes and cylinders, the concentrations of solutions, the model and manufacturer of any complex apparatus, etc.
- ❏ I included a control sample or group, which I will use for comparison and verification (if applicable).
- ❏ The method used to change and measure the manipulated variable is full, clear and detailed (including tools, units, and uncertainty)
- ❏ The method used to measure the responding variable (DV) is full, clear, and detailed (including tools, units and uncertainty)
- ❏ The collection of data with other students or from outside sources is explained and referenced, if relevant
- ❏ The method used to maintain and measure controlled variables is full, clear, and detailed (including tools, units and uncertainty)
- ❏ There is a detailed description of what measures were used to ensure experimental measurements are valid and consistent.
- ❏ I describe what type of data analysis will be done. I mentioned the statistical analysis I will use to verify my claim/s (justifications are done in the data analysis section).
- ❏ The data gathered enables the aim/research question to be adequately addressed. I have enough trials/samples to analyze.
- ❏ Citations relevant to the methodological information are provided
- ❏ There are captioned photographs of the investigation setup and data collection, which are references within the text
- ❏ In the case of databases and simulations, I will include screenshots to explain how the data was captured.
- ❏ Overall, any reader can readily understand how the methodology was implemented and could, in principle, repeat the investigation, as the methodology is clear, concise, and easy to follow.

DATA ANALYSIS

This criterion assesses the extent to which the student's report provides evidence that the student has recorded, processed, and presented the data in ways relevant to the research question.

MARK	ASPECT		
	Clear and Precise Communication	**Consideration of Uncertainty**	**Appropriate and Accurate Data Processing**
0	The students report does not reach a standard described by the descriptors below.		
1-2	The recording and processing of the data is communicated but is **neither clear nor precise**.	The recording and processing of data shows **limited evidence** of the consideration of uncertainties.	Some processing of data relevant to addressing the research question is carried out but with **major omissions, inaccuracies or inconsistencies**.
3-4	The communication of the recording and processing of the data is **either clear or precis**e.	The recording and processing of data shows evidence of a consideration of uncertainties but with some significant **omissions or inaccuracies**.	The processing of data relevant to addressing the research question is carried out but with **some significant omissions, inaccuracies or inconsistencies**.
5-6	The communication of the recording and processing of the data is both **clear and precise**.	The recording and processing of data shows evidence of an **appropriate consideration** of uncertainties.	The processing of data relevant to addressing the research question is carried out **appropriately and accurately**.

CLEAR AND PRECISE COMMUNICATION

Clear communication means that the method of processing can be understood easily. Precise communication refers to following conventions correctly, such as those relating to the annotation of graphs and tables or the use of units, decimal places and significant figures.

Clear Communication of Data:

- ❏ Narrative text references figures and tables
- ❏ Graphs, tables, and images are included as close as possible to its first reference
- ❏ Raw data is clearly presented for the range of levels and number of repeats described in the methodology
- ❏ Data to show consistency of controlled variables is clearly presented
- ❏ Tables and graphs do not break across pages
- ❏ Insightful and thorough qualitative data is presented (maps, sketches, observations and/or photos with annotations)
- ❏ Clear explanation with justification for the descriptive analysis (central tendency and spread of data)
- ❏ Clear explanation with justification for the inferential analysis (statistical significance testing)
- ❏ Statistical test(s) include null and alternative hypothesis and probability levels (p values).
- ❏ Clear explanation with justification for the type of data visualization/graph, including use of trendlines
- ❏ All data, graphs and images are relevant to the research question

Precise Communication of Data

- ❏ Graphs/tables/images are sequentially titled (i.e. "Figure 1…")
- ❏ Metric measurement units are used
- ❏ Tables are well organized, with specific and clear titles, headings and units

- ❏ Data tables are well organized either by groups or types of data
- ❏ Table column headers are present and correct (MV in first column)
- ❏ Correct and consistent number of decimal places
- ❏ Correct number of significant figures
- ❏ Graph is well organized, with specific and clear title, labeled axis (with unit) and appropriately scaled axis

CONSIDERATION OF UNCERTAINTY

Measurement Uncertainty:

- ❏ Correct uncertainty of all measuring device(s) reported for raw measurements
- ❏ Uncertainties of measuring device(s) justified and/or explained
- ❏ Uncertainty of measurement(s) indicated in the column header of the data table
- ❏ Discussion of the size of measurement uncertainties compared to the data collected

Variation within Raw Data:

- ❏ Variation within the data collected is described with reference to outliers, skew, standard deviation and/or interquartile range
- ❏ Variation within the data is visualized as error bars on the graph(s)

APPROPRIATE AND ACCURATE DATA PROCESSING

"Major omissions" = inaccuracies or inconsistencies impede the possibility of drawing a valid conclusion that addresses the research question.

"Significant omissions" = inaccuracies or inconsistencies allow the possibility of drawing a conclusion that addresses the research question but with some limit to its validity or detail.

Appropriate Data Processing:

- ❏ Per trial calculations to determine RV, if necessary (i.e. rate or percent change)
- ❏ Skew or outlier analysis is performed, if relevant
- ❏ Appropriate measure of central tendency (mean, median, mode) is calculated, if relevant
- ❏ Appropriate measure of variation (SD, IQR, range) is calculated, if relevant
- ❏ Appropriate inferential test is performed, if relevant
- ❏ Correct conclusion of significance is drawn
- ❏ Appropriate type of graph is selected for data visualization
- ❏ Appropriate trendlines are added to the graph, if relevant

Accurate Data Processing:

- ❏ Per trial calculations to determine RV are mathematically correct, if relevant
- ❏ Skew or outlier analysis is mathematically correct, if relevant
- ❏ Measure of central tendency calculation is mathematically correct, if relevant
- ❏ Measure of variation calculation is mathematically correct, if relevant
- ❏ Inferential test calculation is mathematically correct, if relevant
- ❏ Formula, Excel formula, worked example or screenshot of calculations given

CONCLUSION

This criterion assesses the extent to which the student successfully answers their research question with regard to their analysis and the accepted scientific context.

MARK	ASPECT	
	Conclusion	**Scientific Context**
0	The students report does not reach a standard described by the descriptors below.	
1-2	A conclusion is **stated** that is relevant to the research question but is **not supported** by the analysis presented.	The conclusion makes a **superficial comparison** to the accepted scientific context.
3-4	A conclusion is **described** that is relevant to the research question but is **not fully consistent** with the analysis presented.	A conclusion is **described** that makes **some relevant** comparison to the accepted scientific context.
5-6	A conclusion is **justified** that is relevant to the research question and **fully consistent** with the analysis presented.	A conclusion is **justified** through **relevant comparison** to the accepted scientific context.

CONCLUSION

A conclusion that is **fully consistent** requires the interpretation of processed data including associated uncertainties.

Conclusion Statement:

- ❏ State the most crucial outcome(s) of the investigation
- ❏ I restated the aim or research question of my study.
- ❏ Based on the results I obtained, I answered the science question/aim (no matter how wrong I think the results are!). - Claim
- ❏ I support my conclusion by mentioning patterns and trends in data stated, with reference to the graph/ tables. - Evidence
- ❏ Comparisons, if appropriate, are made. - Evidence
- ❏ I researched and included the scientific explanation for the results (especially HL students! Look for mechanisms involved). - Reasoning
- ❏ Avoid reference to “proof” of “proves”

Consistency with Analysis:

- ❏ The conclusion is correct and clearly supported by the interpretation of the data
- ❏ Key data from the analysis is given and trends in the data are discussed

SCIENTIFIC CONTEXT

Scientific context refers to information that could come from published material (paper or online), published values, course notes, textbooks or other outside sources. The citation of published materials must be sufficiently detailed to allow these sources to be traceable.

- ❏ Scientific explanation for the results is described
- ❏ I compared my study's results with published data and similar scientific studies. I evaluated if my results support what is already known/studied (this is why you need to research first before choosing an experiment to work on).

- ❏ Evidence from published material is utilized for comparison.

EVALUATION

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation methodology and suggests improvements.

MARK	ASPECT	
	Weaknesses or Limitations	**Improvements**
0	The students report does not reach a standard described by the descriptors below.	
1-2	The report **states generic** methodological weaknesses or limitations.	Realistic improvements to the investigation are **stated**.
3-4	The report **describes specific** methodological weaknesses or limitations.	Realistic improvements to the investigation that are **relevant to the identified weaknesses or limitations**, are **described**.
5-6	The report **explains** the relative **impact** of **specific** methodological weaknesses or limitations.	Realistic improvements to the investigation, that are **relevant to the identified weaknesses or limitations**, are **explained**.

WEAKNESSES OR LIMITATIONS

- ☐ Weakness/ limitations are specific to the methodology of the investigation
- ☐ Explain how the investigative design may have introduced limitations/weaknesses
- ☐ I referenced error bars (or STDEV) about the suggested reliability of results (when applicable).
- ☐ I evaluated the reliability of the results I obtained. I commented on the precision, accuracy, and uncertainty in the data.
- ☐ I addressed whether or not I had sufficiently collected data to answer my research question.
- ☐ I addressed whether or not the range I used for my variable was appropriate.
- ☐ I comment on the design of the experiment.
- ☐ I attempted to explain the reason behind the anomalous results (if applicable).
- ☐ I explained the relative impact of data collection errors and limitations on results.
- ☐ Explain the impact of the weakness/limitations of procedural steps, if relevant
- ☐ Explain the impact of weakness/limitation in the control of variables, if relevant
- ☐ Explain the impact of weakness/limitation in the sample size or number of repeated measures/trials, if relevant
- ☐ Explain the impact of weakness/limitation in the number of level of manipulation, if relevant
- ☐ Explain the impact of the appropriateness of the apparatus in obtaining relevant data, if relevant
- ☐ Explain the impact of variation of the data on strength of the conclusion, if relevant
- ☐ Explain the impact of systematic errors, if relevant
- ☐ Explain the impact of random errors, if relevant
- ❏ Explain the impact of outlier data or irregularities in the data, if relevant

SUGGESTIONS

- ❑ For each source of error I mentioned, I included suggested ways to improve the experiment and explained why this could help improve the quality of the investigation.
- ❑ My suggestions for improvement are realistic and achievable.
- ❑ My suggested improvements effectively and specifically address the limitations.
- ❑ Improvements are relevant to the identified weaknesses/limitations
- ❑ After evaluating and stating my recommendations for improvement, do I still stand by my conclusion?
- ❑ At the very end of this section, I provide possible ideas for future studies (extensions) that connect the research study to potential real-world applications.

** Use this format for this section of my paper:

Sources of Error (include all possible ones!)	**Implications on the Quality of Data Collected (Low/Significant)** (include scientific explanations!)	**Suggestions for Improvement** (if given a chance to do this experiment again, what should be done to improve the quality of the data?)

After evaluating and stating my recommendations for improvement, I (still stand by my conclusion / do not stand by my initial conclusion) because……