Comments on assessed work

Example 7: Electroplating with copper

Title of experiment: Electroplating of an iron nail with copper

Type of experiment: Hands-on

Marks awarded

Criterion	Mark awarded	Maximum number of marks available
Research design	6	6
Data analysis	6	6
Conclusion	6	6
Evaluation	6	6
Total	**24**	**24**

Note: In the criterion descriptions that follow, the strands highlighted in grey are those that best match the work submitted for assessment.

Research design

This criterion assesses the extent to which the submitted work effectively communicates the methodology (purpose and practice) used to address the research question.

Marks	Level descriptor
0	The 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.

Clarifications

A research question with context should contain reference to the dependent and independent variables or two correlated variables, include a concise description of the system in which the research question is embedded, and background theory of direct relevance.

Methodological considerations include:

- the selection of the methods for measuring the dependent and independent variables
- the selection of the databases or model and the sampling of data
- the decisions regarding the scope, quantity and quality of measurements (for example, the range, interval or frequency of the independent variable, repetition and precision of measurements)
- the identification of control variables and the choice of method of their control
- the recognition of any safety, ethical or environmental issues that needed to be taken into account.

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.

Commentary for research design

The research question includes independent and dependent variables. The system's description includes sufficient details to understand the purpose of the investigation. The relevant theory is well used, extending beyond the level of the course. (5–6)

The methodological considerations are carefully addressed, and each step is justified in terms of the theory. The selection of range, methods used for controlling variables and number of repetitions will allow for collecting sufficient data. (5–6)

The description of the methodology includes sufficient detail for the experiment to be repeated. (5–6)

Data analysis

This criterion assesses the extent to which the submitted work provides evidence that the data has been recorded, processed and presented in ways that are relevant to the research question.

Marks	Level descriptor
0	The 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 precise. • 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.

Clarifications

Data refers to quantitative data or a combination of both quantitative and qualitative data.

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.

Consideration of uncertainties is subject specific and further guidance is given in the TSM.

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.

Commentary for data analysis

The communication of both recording of data and processing is clear and precise. The difference in decimal places between the uncertainty and reported values has been previously justified and does not affect the high quality of the material. The conventions are well used. (5–6).

There is a careful consideration of uncertainties, and the candidate uses several methods—including propagation, line of best fit, comparison with theoretical values and R^2. (5–6)

Sufficient data have been collected. The values are concordant. The processing is carried out correctly and will allow for appropriately and accurately answering the research question. (5–6)

Conclusion

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

Marks	Level descriptor
0	The 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 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.

Clarifications

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

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.

Commentary for conclusion

The conclusion is consistent with the detailed analysis. The student shows awareness of its limitations and makes evident efforts to justify differences by correctly using associated uncertainties. Systematic errors and directions are explained. (5–6)

There is a permanent use of the scientific context throughout the entire investigation, and the conclusion is well justified with arguments supported by theoretical data and published material. (5–6)

Evaluation

This criterion assesses the extent to which the submitted work provides evidence of evaluation of the investigation methodology and has suggested improvements.

Marks	Level descriptor
0	The 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.

Clarifications

Generic is general to many methodologies and not specifically relevant to the methodology of the investigation being evaluated.

Methodological refers to the overall approach to the investigation of the research question as well as procedural steps.

Weaknesses could relate to issues regarding the control of variables, the precision of measurement or the variation in the data.

Limitations could refer to how the conclusion is limited in scope by the range of the data collected, the confines of the system or the applicability of assumptions made.

Commentary for evaluation

There is a thorough analysis of the impact of the methodological weaknesses and limitations with solid explanations. (5–6)

The candidate introduces improvements during the design stage, which receive credit. There is a good analysis of possible improvements and identification of those that are not possible or realistic at school level. (5–6)