Comments on assessed work

Example 2: Distribution coefficients of ammonia

Title of experiment: Investigation on the Distribution Coefficients of Ammonia between Water and three Different Chloroethanes

Type of experiment: Hands-on

Marks awarded

Criterion	Mark awarded	Maximum number of marks available
Research design	5	6
Data analysis	4	6
Conclusion	4	6
Evaluation	3	6
Total	**16**	**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 provides enough details on the system and the relevant theory is presented. Challenges resulting from titrations in non-aqueous systems exceed the level of the course. (5–6)

Variables are correctly identified; the candidate justifies the selection of compounds but states their number, which is insufficient for establishing a trend. The method used for the control of variables is explained to some extent. The control of temperature is not well managed and assumes pressure remains constant. Safety issues are well addressed but the disposal of leftovers is not. There are explanations missing, the number of points is insufficient and there is not efficient control of temperature, which should have been monitored. The low end of the 3–4 markband seems fair in this case.

The methodology is described with sufficient detail to repeat it. (5–6)

This could be awarded 4 or 5 marks. The two descriptors in the 5–6 markband are sufficiently well met to award 5 marks when using the model of best fit.

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 and processing is mostly precise but not always clear. The high end of the 3–4 markband correctly describes the material.

The candidate considers uncertainties, but their propagation shows some inaccuracies. Finding %difference and identifying random and systematic errors add value. There is no line of best fit, and no R^2 is reported. (3–4)

The candidate attempts to establish a trend that is not possible with just three values. An outlier is identified during the evaluation. Using differences in electronegativity fails to consider the geometry of the molecules. The candidate admits this during the conclusion, but this processing is limited and cannot adequately answer the research question. (3–4)

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 not fully consistent with the presented analysis; it answers the research question to a limited extent. The candidate recognizes the trendline is not linear, but the anomalous value is only identified. The significant difference between the Kp of 1,1,1,2-tetrachlorethane and the other two compounds should be addressed in greater detail. Associated uncertainties are described. The justification is attempted but vague. The candidate does not give the direction for the systematic error. (3–4)

The conclusion considers the scientific context when addressing the polarities of the different parts of the structures but fails to use it for explaining the significant difference in the last Kp or the lack of linearity. (3–4)

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

The candidate identifies the methodological weakness resulting from only working with three compounds. There is no record or control of the temperature and this methodological weakness is superficially addressed. An award of 3 marks seems fair in this case.

The report includes one explanation on the change of indicator introduced during the pilot. The rest of the improvements are stated. This section is not well handled and the high end of the 1–2 markband correctly describes the material.

The evaluation could be awarded either 2 or 3 marks, but in terms of achievement the low end of the 3–4 markband seems to correctly describe the overall quality.