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| **IB Physics Internal Assessment**  **Comments on Student Script “G”**  Research Design, Data Analysis, Conclusion, Evaluation | SafariScreenSnapz001.tif |

**“The Relationship Between the Different Surface Areas**

**of the Beaker and the Evaporation Levels of Water”**

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| **Research**  **Design 0 – 6** | **Data**  **Analysis 0 – 6** | **Conclusion**  **0 – 6** | **Evaluation**  **0 – 6** | **Total**  **0 – 24** |
| **3** | **3** | **2** | **1** | **9** |

#### Research design assesses the extent to which the student effectively communicates the methodology (purpose and practice) used to address the research question

**Research Design Assessment is a low 3**

**Research Design 1st Descriptor level 3**

The **research question** is outlined within a broad and somewhat appropriate context; however, some of the text is expressed in confusing and repetitive ways. Temperature and surface area are stated as key factors. The student selects a near boiling temperature to enhance the rate of evaporation. The cover area and the water surface area expressions seem to be interchanged at times; the water evaporated, and the remaining water are also often interchanged. There are other key factors not mentioned until the Evaluation. Diagram 1 is a prediction of the results, but here we see an increased surface area (presumably of the cover but stated as beaker surface area) resulting in a decrease of evaporation volume. This is a good example of the often-confusing text. The first descriptor earns level 3. A more precise and focused background would be needed for a higher mark.

**Research Design 2nd Descriptor at a low level 3**.

For this investigation one would normally use different sized beakers. According to the sketch, there is significant air space above the water level and the lower side of the cover. No doubt convection currents as well as evaporation can occur in this space as well as in the uncovered space. This approach is not a good design. A photograph would have been helpful. The procedure for producing the lids is explained in detail. We are not told why five minutes was chosen, but this interval with near boiling water should work. Repeated measurements are made, and the range is reasonable. Relevant and sufficient data is possible. Safety issues were addressed. However, the quality and reliability of data have not been addressed. More is needed on controlled variables. The methodology is described (or at least an ‘attempted description’), with some ambiguities. The second descriptor is on the borderline of 2 and 3, earning a low level 3.

**Research Design 3rd Descriptor level 3.**

Despite conceptual confusions, we can figure out what the student is going. We could reproduce this given some ambiguities and perplexities. However, we are also reading into this simple lab a better way to explain and perform it. For example, to determine the volume of evaporated water after five minutes, we only see an example calculation (volume of liquid before minus volume of liquid after equals volume of water evaporated in five minutes). This obvious step was not mentioned under the dependent variable (a missing step in the instructions). The third descriptor earns level 3.

#### Data analysis assesses the extent to which the student’s report provides evidence that the student has recorded, processed and presented the data in ways that are relevant to the research question.

**Data Analysis Assessment is best fit at a low level 3.**

**Data Analysis 1st Descriptor level 2**

The communications of the recording and processing of the data is somewhat precise (but with some inconsistencies) and not always clear (with some confusion). There is something suspicious about all the raw data of water volume measurements after evaporation ending with the first decimal place being “0”. This is not realistic or statistically plausible. We can then say that the data is neither clear nor precise. Processing is limited to the calculation of an average and the drawing of a graph. Some calculations are wrong. Again, the term surface-area is confused.

**Data Analysis 2nd Descriptor level 3**

Measurement uncertainties are mentioned. Basic processing of uncertainties is done on the evaporated volume. There are mistakes in the propagation of uncertainties, and the student’s results are too small. How do we understand an angle of 36° with an uncertainty of ± 0.06°? There are other inconsistent significant figures. Uncertainty bars appear nicely on the graph. Would the extension of the linear graph line for zero evaporation equal the surface area of the beaker? We don’t know (moderator’s estimation of about 300 cm3).

**Data Analysis 3rd Descriptor at a low level 3**

Known theory tells us that the rate of evaporation is directly proportional to the surface area of the water. That would be a graph of the amount of evaporation against water surface area, and this would be a linear graph line going through the origin (hence proportional) and with a positive gradient. The student’s graph shows a decrease in evaporation with an increase in ‘surface area’. However, if the data is for the covered area, then the function is linear with a negative gradient (as shown). Perhaps the student graphed the cover area, not the water surface area. Some of the comments remain confused or at least confusing to the examiner. The amount of evaporated water after five minutes seems rather large, but the value is the same magnitude as a textbook value for near boiling water for the same surface area. We can give the student benefit of doubt here. However, given the abstruse graph when the obvious function should have been made, we can say there is a significant omission.

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

**Conclusion Assessment** **is a best fit at a low level 2.**

**Conclusion 1st Descriptor level at a low 3**

If we interpret the student’s data as presented, we can say that the RQ has been implicitly addressed and described (but not justified or clearly understood). The student states "when the surface of the beaker decreases, the amount of evaporated water decreases" which is the same as saying that when the surface area increases so the evaporation increases. A qualitative statement is correct: the larger the cover area, the less evaporated water, but this is not the same to say that evaporation is proportional to surface area (the textbook hypothesis). A Qualitative observation does not confirm a quantitative function. See the graph below that the examiner made using the student’s data. The student’s data does not support the known function of area and evaporation. The student claims that for their graph the line does not go through the origin (“as expected”), which shows the graph is not proportional, not as they expected. What could the student be thinking here? We can say that the student’s analysis relates to the known theory, but that is all. Because of the surface area confusion, we must say that the conclusion is simply described but is not fully consistent. Assessment is borderline 2 to 3 but given the best fit would be a low 3.

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| The examiner calculated the water surface area in the beaker, and graphed evaporated volume after five minutes against the water surface area.  A positive gradient linear line is formed, but not the proportional function that the student quoted in the RQ. Why did the student fail to graph the obvious quantities? | A graph with a line and a chart  Description automatically generated with medium confidence |

**Conclusion 2nd Descriptor level 1.**

The conclusion is stated, repeated several times in various forms, and the only context is the known relationship of surface area to evaporation (directly proportional). This is then consistent with the references seen in the footnotes. How do we assess this? The footnotes are there, and theory is there, but the experimental data does not align in a quantitative way. More than a general qualitative statement is expected at the IB level, so we can only award this descriptor at level 1 for a somewhat superficial comparison. More explicit attention (understanding and proper analysis) would be needed for a higher mark band.

#### Evaluation assesses the extent to which the student’s report provides evidence of evaluation of the investigation methodology and has suggested improvements.

**Evaluation Assessment best fit level is 1** (see official guidelines on when a zero level is appropriate and how to establish a best-fit).

**Evaluation 1st Descriptors level 3.**

The first problem recognized by the student is that their graph does not pass through the origin, as they ‘expected’. As they expected? Then we are told that the best fit graph shows that the hypothesis is confirmed. More ambiguity. These student comments do not address the Evaluation criterion and were addressed under Conclusion. The two weaknesses mentioned under the Evaluation section of the report were appropriate. First, there was too much air space between water surface and carboard lid. It is not clear why this would change the air pressure as the student claims, but it would affect the quality of surface area data measurements. Why not just have different sized beakers (as other students have done with this investigation)? Second, the act of moving water from the beaker to the measuring cylinder was mentioned. Yes, evaporation is always happening but also water is lost to the surface. Why not just measure the mass before and after? The student has described specific weaknesses but did not effectively explain the relative impact of these. Assessment level 3.

**Evaluation 2nd Descriptors level 0.**

Yes, using more water (for the given method) would have been more appropriate but the second descriptor has not been addressed. More insight and thought are needed for any fair assessment.

**—end**—

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