Physics Exploration criteria requirements:

**Personal Engagement:**

Dos:

1. Be an independent thinker by taking up self – initiative and applying creativity.
2. Give justification for choosing the research question.
3. The topic under investigation must demonstrate personal significance, interest and curiosity.
4. There must be evidence of personal input and initiative throughout the exploration.
5. Combine syllabus content with personal interest.
6. Be focussed on the research question.
7. Be enthusiastic and passionate about the topic.
8. If it revolves around a simulation, show some initiative in choosing the right simulation among various simulations which would help confirm the known equation.
9. A lot of thought must be implemented into the project.
10. It’s good to see a mathematical model being associated with a hands – on physics experiment; not necessarily though.
11. There must be more than one or many references to personal interest.

Don’ts:

1. There is little evidence of personal input or initiative.
2. There is no genuine interest or curiosity for the research involved.
3. There is only a slight personal connection to the topic.
4. There is hardly one, two or any reference to personal engagement in the exploration.
5. The design and method of the experimentation are straightforward and demonstrates no personal input/s.
6. There is no insight, creativity and independent thinking.
7. The justification for choosing the topic is minimal.

**Exploration:**

Dos:

1. The topic of the investigation is identified and a relevant and fully focused research question is clearly described.
2. The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation.
3. 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.
4. The report shows evidence of full awareness of the significant safety, ethical or environmental issues that are relevant to the methodology of the investigation.
5. Sufficient social and historical, as well as scientific, background is covered.
6. The method of analysis and presentation are relevant.
7. The student has identified and focused on an appropriate investigation, and one that is interesting.
8. Various sections clearly and concisely state the relevant scientific context, and this dovetails nicely with the physics syllabus.

9. If the exploration is based on a simulation, the student appreciates the limitations of using a simulation.

10. The methodology, given the limited nature of modelling, is most appropriate and indeed proves interesting (in the case of explorations based on modelling).

11. The methods used are totally appropriate to the physics Diploma Programme.

Don’ts:

1. There is much more scientific context that needs to be explained.

2. 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.

3. 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.

4. There is no thought given to the method; the student assumes essential aspects.

5. The methodology is mostly mere calculations, much like a homework assignment.

6. The student is not aware of assumptions, accuracy and precision in the data, errors and uncertainties.

7. The variety of experiments makes any single research question unfocused.

8. There is some weak use of language and the student often needs to get to the point more directly.

9. The student shows no or some awareness of the key safety issues.

Analysis:

Dos:

1. The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question.

2. 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.

3. The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis.

4. The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.

5. The student did make a reasonable attempt at evaluative analysis.

6. The student has selected, recorded and processed appropriate data. He or she also appreciated the scope and limitations of the data.

7. There is no doubt that the student has selected, recorded, processed and then interpreted the data in a way that directly addresses the question.

8. The range of data is adequate (indeed, with a simulation the range may or may not be a significant issue).

9. The accuracy of the data has been represented with error bars where appropriate.

10. The research question has been addressed, answered, explained and understood.
Don’ts:

1. Some basic data processing is carried out but is either too inaccurate or too insufficient to lead to a valid conclusion.
2. The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis.
3. The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.
4. The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question.
5. The study includes relevant but insufficient data, the processing is basic but confused, there is the expression of errors and uncertainties but they are not related to the measurements themselves, and the overall interpretation is confused.
6. The impact of uncertainties has not been addressed under analysis (it could be a part of conclusion, though).
7. The lack of any awareness of assumptions, errors, uncertainties, precision, accuracy or even significant figures is a fault under the analysis criterion.
8. The student’s research project is so simplistic that there is no question that the simulation will provide a valid conclusion.

**Evaluation:**

Dos:

1. A detailed conclusion is described and justified which is entirely relevant to the research question and fully supported by the data presented.
2. A conclusion is correctly described and justified through relevant comparison to the accepted scientific context.
3. 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.
4. The student has discussed realistic and relevant suggestions for the improvement and extension of the investigation.
5. The conclusion is visually presented and summarized in the text.
6. The data supports the conclusion and the research question has been answered.
7. The student’s conclusion of the investigation clearly addresses the research question and it appreciates in a qualitative sense the degree of accuracy.
8. The results illustrate any given equation, and the data range and graphs were all appropriate.
9. Although the student addresses all the descriptors under evaluation for any modelling investigation, more attention to the conclusions would be needed for the top mark.
10. The student is aware of assumptions and uncertainties and systematic errors throughout the investigation, and these are all addressed in the concluding comments.

Don’ts:

1. A conclusion is outlined which is not relevant to the research question or is not supported by the data presented.
2. 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.

3. A conclusion is described which makes some relevant comparison to the accepted scientific context.

4. No or some attempt was made to evaluate the quality of the data in terms of uncertainties or assumptions.

5. The conclusions as such are properly described but only partially justified.

6. There is no attempt at addressing the methodology or technique of this investigation and improvements or extensions have not been addressed; this is an influencing factor in deciding the final mark.

7. He or she did not do an “interesting” scientific investigation with the data.

8. No thought is given to the scope or limit of the method, data analysis or any other aspect of the methodology.

9. There are no suggestions for improvements.

10. Strengths and weakness are not given the depth that one would like.

**Communication:**

Dos:

1. The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.

2. The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way.

3. The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation.

4. The use of subject specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.

5. The student’s report is clearly written and presented, and there are many illustrations and mathematical calculations to remove any doubt of what the student is talking about.

6. The report flows nicely and is within the page limit. There are a number of personal touches too that help make the work interesting.

7. The structure is clear and divided into manageable sections.

8. The experimental process was clear and the comments were relevant.

9. Moreover, the calculation techniques are explained, and the graphs illustrate beautifully what the reader is to understand.

Don’ts:

1. The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.

2. 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.

3. The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information.

4. There are many errors in the use of subject specific terminology and conventions.

5. The research issues are not as focused as they should have been.
6. A number of sentences are vague, some scientific context and terminology is wrong, and the graphs do not always help the understanding of the data.

7. Sometimes, the student was not as direct as he or she could have been.