Treatment of the topic

Physics essays usually have a title, which sums up the essence of the investigation. It is based on the student's identified topic area.

The research question further refines and defines the topic. It must be expressed as a question, not a statement. It must be expressed clearly and precisely, and appear early in the introduction of the essay and on the title page of the essay.

For example, a student may have noticed how it is difficult to spin an uncooked egg. After discussion with the supervisor, the student decides to fill a tin with liquids of different viscosities and roll them down an inclined plane. The title of the essay may be: "The effect of the viscosity of a body on its angular acceleration."

The research question, though, should be much more specific: "What is the relationship between the angular acceleration of a cylindrical can rolling down an inclined plane and the viscosity of its contents?"

Methods of approach

Students can choose to answer their research question with an essay based solely on theory or one based on data and theory.

If their essay is data based, students can choose to collect their own primary data or use secondary data that has already been collected elsewhere.

Students should consider the reliability of both primary and secondary sources at the start of the planning stage. Students must critically evaluate secondary data and the design of the experiment(s) by which they were collected with the same care that they would their own.

Importance of theory

Every EE in physics will involve applying relevant theory to the topic selected. Students must ground any experimental work in good background research from existing sources of information.

Before embarking on experimental work, students must first ensure that there is scope to explore and model the physics that underpins it. A purely empirical investigation that relates a number of variables in the absence of any theoretical foundation is never satisfactory.

For example, in an investigation relating the index of refraction of a salt solution to its concentration, the student must model the physics relating the index to the concentration.

Using secondary data

Students using data collected elsewhere can access all the assessment criteria and achieve the highest marks. For example, they can obtain astronomical data from databases and manipulate it in order to contribute to a research question that looks for the evidence of extrasolar planets.

Ideally, students will manipulate or analyse this secondary data in an original way. Essays that simply restate facts or data taken directly from the sources are of little value. The element of personal analysis and evaluation is extremely important.

Collecting primary data

Students should choose experiments that do not require extensive lengths of time for the construction of apparatus. Highly sophisticated instruments are rarely required and can hinder the understanding of a phenomenon. Some of the best EEs have been written by students investigating relatively simple phenomena using standard school apparatus, and this approach is to be encouraged.

Students must give a clear and concise description of their experimental procedure so that it can be repeated by others. This will normally involve clearly annotated scientific diagrams. Exhaustive lists of equipment and detailed descriptions of procedures should be avoided.

Theoretical essays

Theoretical essays offer students the challenge of exploring existing material in a new way. This may mean applying the theories and techniques of physics to an unconventional area.

Students may be tempted to incorporate mathematics or computer science, but they must ensure that the focus of the analysis and evaluation is on the discipline of physics.

Where computer programs are used and analysed from a physics perspective, they should be placed in the appendix. Each line of code of a program fragment included in the body of the essay will count as two words towards the word limit.

Examples of topics, research questions and suggested approaches

Once students have identified their topic and written their research question, they can decide how to research their answer. They may find it helpful to write a statement outlining their broad approach. These examples are for guidance only.

Topic	**The relationship between the dimensions of an exhaust pipe and the sound it emits**
Research question	What is the relationship between the length of an exhaust pipe and the frequency of the sound it emits?
Approach	A clear opportunity for theory here and this can be supported by a student-designed simulation. Conducting the experiments may be difficult but can be achieved by analysing the recorded sound.

Topic	**The time taken to reach terminal velocity**
Research question	How does the time taken to reach terminal velocity depend upon the viscosity of the fluid it is falling through?
Approach	This is a good opportunity for experimentation using a viscous liquid. Quantitatively measuring viscosity and changing the viscosity without changing other variables will provide additional challenges. Mathematically modelling using a spreadsheet simulation will help to determine the expected answer.

Topic	**The temperature dependence of the sound of flowing water**
Research question	How does the frequency spectrum of the sound of running water depend upon its temperature?
Approach	This would be a very doable challenge. The student would be expected to do the experiment and also to find some way of accounting for and modelling the change of frequency observed.

An important note on "double-dipping"

Students must ensure that their EE does not duplicate other work they are submitting for the Diploma Programme. For example, the same experiments cannot be used for the EE and the internal assessment or other practical work carried out during the course.

The physics EE and internal assessment

In particular, an EE in physics is not an extension of the internal assessment (IA) task. Students must ensure that they understand the differences between the two.

- The IA is more likely to focus on the syllabus content, whereas the EE can explore aspects of physics not covered in the syllabus.
- The IA must include data collection and analysis (from hands-on experiments, databases, simulations or modelling) and cannot purely be a literature review.
- The EE must construct a theoretical framework for the underlying physics of the chosen topic, whereas the IA focuses on the application of the scientific method to a problem of interest and will only include some background information.
- The EE explicitly assesses the students' ability to analyse and evaluate scientific arguments.

Supervisors play an important role in guiding students on these distinctions. Students risk their diploma if academic misconduct is detected.