

Physics

Overall grade boundaries

Grade:	E	D	C	B	A
Mark range:	0 - 7	8 - 15	16 - 22	23 - 28	29 - 36

The range and suitability of the work submitted

There was clear evidence that a majority of students received relevant information and good guidance from their supervisor. The enthusiasm and dedication of the majority of students was recognized. Many supervisors included their comments on the cover sheet.

Overall the topics were well chosen, even for those candidates who did not manage to fully develop, throughout the essay, what they had initially planned. The large majority of topics were relevant to physics. Essays varied in standard from excellent to poor. A number of essays based on a simple and original topic, were well developed. It was not always evident that candidates were fully aware of the EE requirements or familiar with the EE guide.

A wide range of topics covered different areas of physics for example:

Simple pendulum oscillating in water; Penetration in ice of a wire under tension; Efficiency of an Archimedean Screw water pump;; Firmness of sand: effect of grain size and water content; Efficiency of a Sterling engine; Physics of free throw in game of basketball; Friction between flexible rope and capstan; Reverberation time of sound on velvet curtains; Magnetic field inside a solenoid; White dwarf stars and gravity; How do the physical properties of viola strings affect the harmonics intensity of sound?; Mass effect on a winged samara's flight time; Effect of number of blades and power generated by wind turbine; Maximum range of badminton shuttle; How does increasing the area of paper placed in rectangular ice blocks affect the transverse strength of the ice block?; Effect of light intensity on output of a solar cell.

Personal interest was always a great source of motivation; however the challenge was to work within the frame work of what an EE in physics needs to be. Some students seemed to have realized early in their investigation that the topic was more complicated than anticipated but still chose to keep the topic and research question. Some students chose a topic in an area of physics that challenged them, which is not necessarily a good strategy to follow. Solar photovoltaic cells and sports were popular choices.

Candidate performance against each criterion

Criterion A: research question

In most cases, the topic was appropriate to physics, and the research question was clear and reasonably focused.

Criterion B: introduction

A significant number of students obtained lower marks because of a weak physics context or, often, an absence of physics context. An efficient approach would be to describe the investigation related to the research question in terms of physics principles. Occasionally the requirements for the abstract and the introduction were confused. A hypothesis does not replace the required physics context. Generally the hypothesis should not be part of the introduction.

Criterion C: investigation

A majority of students achieved a mark 3 or 4. Generally in experimental essays a proper procedure was chosen. Some lack of repetitious data made it difficult to appreciate the reliability of the data and procedure as well as to reduce the uncertainty attached to random errors. In some cases there was insufficient data.

Criterion D: knowledge and understanding of the topic studied

Good essays contained quantitative physics developed by the candidate with some reference to academic sources and literature. However, this was typically a weak point of a number of essays where no model or physics theory was proposed, or done so very superficially, without any prediction relating the variables under investigation, predictions to be considered in the analysis and evaluation. The statement of a hypothesis without physics or limited physics is not satisfactory.

Criterion E: reasoned argument

Generally the shape and form of the essay followed a logical and reasoned structure in line with the research question. Weaknesses included unfounded statements such as “it is evident from the graph that ...” or a lack of links between the different parts of the essay or within a part of the essay. It is useful to inform the reader what the next step is and the reason for it. The argument should be fluent and uninterrupted. For this purpose, a sample(s) of raw data should be integrated in the body of the essay. The appendix is not part of the essay and the examiner is not required to read it, therefore no new information should be introduced in the appendices. It is good to integrate graphs when possible and avoid repetitious data, which is a common weakness.

Criterion F: application of analytical and evaluative skills appropriate to the subject

There was clear improvement in the manipulation of significant data and an awareness of uncertainties were observed. At times uncertainties were not consistent with numerical values e.g. not carrying the same number of decimals (e.g. $16.8 \text{ V} \pm 0.05 \text{ V}$). The precision of an instrument and the absolute uncertainty should be utilized properly. The practical uncertainty attached to a measurement should be realistic e.g. the use of a measuring tape to determine long distances will not be precise within a few millimetres. Efforts were made in propagating errors but the determination of the uncertainty attached to an average value still eluded many.

A good analysis must compare the results to theoretical predictions and/or to results extracted from literature. A typical question to answer is “is the theoretical value within the uncertainty range of the experimental value? If not, why?”. A reliance only on mathematical software does not satisfy the need to relate the analysis and evaluation to physics.

Criterion G: use of language appropriate to the subject

This criterion is about communication. Aside the use of physics terminology, the student should use key diagrams to explain the theory or to illustrate the set-up. Generally diagrams or figures were significantly underused. Curves on graphs should be described precisely, the adjective “exponential” being typically overused. What helps communication is having diagrams, tables of data and graphs all numbered and labelled as well as explicitly referred to by number in the text.

Criterion H: conclusion

A large number of candidates obtained one mark. Conclusions were related to the research question but, at times, were not clear because the student did not take a clear stand, hesitating because of the uncertainties or limitations. The impact of the key limitation(s) must be reflected in the analysis and conclusion.

Criterion I: formal presentation

This is a multi-faceted criterion. Most students achieved 2 or 3 marks against this criterion. Main areas of weakness: not consistently applying an academic referencing system and listing all and only those sources referenced in the body of the essay. A list of equipment and procedural instructions given in a ‘cookbook recipe style’, should be avoided in a physics EE. Annotated set-up diagrams are ideal. A physics essay will show the student how a scientific paper is to be organized and presented.

Criterion J: abstract

Most students obtained 1 mark against this criterion. The second required element “how investigation undertaken” was often incomplete or too vague, thus rendering it unclear. There was a tendency for the conclusion to be too short and limited. In some essays one of the formal requirements was missing.

Criterion K: holistic judgement

The qualities looked for are listed in subject-specific section of the EE guide. Physics knowledge and understanding is part of it. The student should not act only as an informant but should also demonstrate personal insight which adds value. The level of achievement varied between 1 and 4.

Recommendations for the supervision of future candidates

With care and attention given to the technical criteria J, A and B a student can secure six marks. By following the EE guide attentively, listening to the supervisor and taking into

account the recommendations listed above a student should be able to reach at least a solid satisfactory level. The supervisor is invited to help, assist and guide the student especially when a serious and consequential situation develops. This can be done in a Socratic manner, respecting the student's ownership of their work. A wise selection of the topic for study is crucial.