Physics

Overall grade boundaries

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

The range and suitability of the work submitted

A quite diverse range of topics were submitted for assessment with a good number of relevant topics, covering all areas of physics. Irrelevant topics were seldom encountered. Many essays were well researched and of good quality, as well as being well-executed. Candidates make an effort to demonstrate personal engagement and opinion, rather than simply managing and reordering collected information. Essays on sport often lacked some control of variables as well as solid physics background, or were too ambitious. Bio-mechanics is a complex domain. Many essays involve aerodynamics or hydrodynamics, highly complex topics of physics. A realistic and achievable choice of topic here is critical if superficiality is to be avoided. The best essays usually require theory that is already familiar to the candidate. The essays should usually be accessible to their peers, the EE supervisor and the examiner. A good strategy is to avoid attempting an investigation above one's academic ability. On the other hand, some essays are simply an extended "internal assessment" investigation not in line with the objectives of an extended essay in physics. Purely empirical essays do not do well, and nor do essays with too broad a research question. Among the best essays are essays investigating an original (for the candidate) phenomenon, presenting a theoretical model and then performing an experimental test of the proposed model. Some experiments that are poorly designed, bound to fail or produce unusable results suggest that the students are clearly not thinking while they are performing the practical work.

Candidate performance against each criterion

Criterion A: research question

While it is rare that the topic and research question (RQ) are completely unsuitable, often the RQ is too broad or unclear because terms are not defined or the context not described. The reader should know exactly what the issue is and the conditions under which it will be investigated.

Criterion B: introduction

The introduction must contain the principles of physics relevant to the RQ. This is a common weakness, too often this essential aspect is missing. The formal development of the theory comes after the introduction. A number of candidates get too personal with regard to significance and worthiness.

Criterion C: investigation

This criterion is multi-facetted. At times the volume of data is too limited or the procedure followed questionable. An experimental graph should carry at least seven data points. Definitively the extended essay requires more work than an average IA investigation.

Criterion D: knowledge and understanding of the topic studied

The physics theory should evolve into a model that can generate verifiable predictions or can be verified experimentally. The implications on the analysis are direct. The absence of relevant theory or a weak theory have a negative impact on a number of criteria, for example criteria C, D, F,G and K. Candidates find the establishment of a personalized theory well aligned to the RQ difficult to achieve. The theory should not be general but specifically applied to the RQ. Clear understanding is to be demonstrated. Often candidates did not explain the theory in their own words and did not illustrate their explanations.

Criterion E: reasoned argument

A common thread must clearly connect each stage of the investigation and the focus on the RQ must remain constant. Too often students wrote: "It is evident that ..." without any attempt to justify their statement or leaving the reader to find out. At times, the clarity of an argument was weakened by a lack of organization or by poor presentation. At times candidates seemed to get lost in a sea of data, being stretch in too many directions. A good number of essays presented a clear reasoning.

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

Without a theory or model to verify, it is not possible to do well in the analysis and evaluation. A purely empirical relationship between variables is not sufficient. Mastery of basic skills expected in the IA program is too often absent or weak (manipulation of significant figures, uncertainties). An improvement in this area was noticeable this session. Candidates tend to accept automatic best-fit curves without critically analyzing the situation, without identifying other options and ignoring a clear trend. Analysis tended to be incomplete and sometimes superficial. Limitations were considered but their implications on the results and conclusion were too often ignored. Secondary sources must be considered and used critically. Many opportunities to display personal candidate analysis, critical thinking, and reflection were not fully seized by relating a statement or value to a simple calculation or comparison (e.g. " what if", "given ..." , "under the limiting conditions of ... an upper bound estimate would be ...", "this can be related to ...where we find that ...", which would be valuable given that such interjections highlight the candidate's thinking and reflection. This is especially true with survey essays which tend to be book reports and information management rather than information enhancement. A good number of essays include good analysis but on average the marks tended to be in the lower range.

Criterion G: use of language appropriate to the subject

This criterion is about communication in all of its forms: use of proper units and proper standards in writing numerical values with units and uncertainties, physics terminology (difficult to achieve if no theory), use of key diagrams or figures to support explanations (often such diagrams are missing or sparsely used). The use of scientific diagrams is necessary, but is, unfortunately, a recurrent weakness that requires serious attention. Usually it is not enough to cut and paste, moreover it is better to produce diagrams created by the candidate which will be better suited to the essay. Candidates should be able to write equations, exponents and indices accurately. All symbols should be clearly defined and, new terms or unusual terminology explained. Software fit-equations should use physics symbols, not y and x. It is unfortunate when a lot of work and efforts are undermined by weak communication.

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

Criterion H: conclusion

Generally candidates did well against this criterion, but at times, there was a lack of consistency or lack of clarity in the conclusion. Most candidates were able to identify weaknesses and limitations, but did not always indicate the implications on the results.

Criterion I: formal presentation

This is a multi-facetted criterion, with variable level of success. Some notable areas of weakness were: table of contents being too generic, annotated diagrams, figures, data tables, graphs not numbered and not labelled (not referred to specifically as a consequence), poor legends, incomplete citations and bibliographies, and not following recommendations that appear in the EE Guide.

Criterion J: abstract

The most common weakness is to forget about the second element of the abstract (that is to say, how investigation was undertaken) or to say little about it. Many abstracts are well focused and well written. There is a noticeable improvement against this criterion.

Criterion K: holistic judgment

Intellectual initiative and added value or personal touch had to be present in order to score highly against this criterion. While improvement has been observed, insight and depth of understanding as well as creativity was not always evident. Many essays were well researched and well reported, and some of them were outstanding with evident candidate enthusiasm.

Recommendations and guidance for the teaching of future candidates

Candidates should:

- read a few (accessible) physics articles from a magazine or physics papers, as there is a lot to be learned about how focused a scientific paper is, how a paper is written and presented.

- read the EE guide carefully, including the physics section very attentively.

- focus on a narrow and realistic topic/ RQ, and work with their supervisor to achieve this. The RQ should be well within their grasp, making initiative and creativity possible, remembering that the "journey" is about physics.

- keep a critical eye at each stage of the investigation.

- keep aside time required to write an essay well argued and well presented.

- remember that any topic needs a crisp theoretical summary coupled to a carefully designed RQ and study.

- use the knowledge acquired in IA investigation, knowing that an EE is different from an IA report both in scope and in presentation.

Supervisors play a key role:

- in assisting candidates in the selection of a topic and RQ. After all this is probably the first formal paper that the candidate will produce. It is unfortunate when an investigation is bound to fail because a poor choice of RQ.

- in identifying potential disasters early so that they can avoided before too much time has been lost in futile pursuit.

- making sure of the authenticity of the candidate's work.

- writing a supervisor's report which will assist the award of marks against criterion K.