May 2018 extended essay reports

Mathematics

Overall grade boundaries

Grade:	E	D	C	B	A
Mark range:	0-6	7-13	14-20	21-26	27-34

The range and suitability of the work submitted

- There were a few essays where the mathematics was elementary. An EE will score poorly if the mathematics used is below IB diploma standard.
- Also there were a few essays that were narratives, with no mathematical analysis. These, too, score poorly.
- Essays that did well included proofs of their conjectures as well as examples to show understanding. Their mathematics was easy to follow and diagrams were included to aid in the analysis. In cases where a proof is too difficult, a clearly explained example is needed.

Candidate performance against each criterion

Criterion A: focus and method

- Students with a Research Question that is not formatted as a question often scored low in criterion A when it was considered on balance with the other requirements of the criterion.
- The research topic, which should be stated, should then be narrowed down to a clear and precise RQ. Candidates can struggle with focus or with the word limit if their RQ is too broad.
- Candidates are reminded to remain focused on the RQ throughout the essay.

Criterion B: knowledge and understanding

- Candidates should always try to give some commentary or example to explain their Mathematics and show understanding.

Criterion C: critical thinking

- Essays that had little to no mathematics scored very low (typically 1 - 3) in criterion C.
- The essays that skipped mathematical steps or did not explain the non-trivial mathematical steps typically scored in the middle of criterion C.
- Essays that included strong analysis, proofs of conjectures and easy to follow mathematics scored in the upper range of criterion C.
- Critical evaluation was not attended to, in an appropriate manner by many candidates. In mathematical terms, this implies clear explanations and evaluation of the significance of results in relation to the RQ.

Criterion D: presentation

- Candidates are reminded that tables should not be split over 2 pages wherever possible.
- Headings should never end a page; move them to the top of the next page.
- Equations should not be split over two lines, for example don't end a line with " $y =$ " and start the next line with " $mx + c$ ". Ideally, equations should be centred and have a line to themselves as per usual mathematical formatting:

$$y \ = \ mx \ + \ c$$

- Essays with helpful diagrams, tables and graphs as appropriate, often scored higher in criterion D.
- Candidates are reminded to use appropriate mathematical notation – for example, * for multiply and ^ for powers are not appropriate.
- 'Body' is not an appropriate section heading.
- Essays that exceed 4000 words will be penalised as the examiner will not read beyond the cut-off point. The penalty applied will depend on the information contained after that point.
- Candidates should use appendices only for data or programs. Essential material must be included in the essay, not in an appendix.

Criterion E: engagement

- Reflections that only discussed supervisor recommendations scored low in criterion E.
- Reflections where candidates discussed problems they had encountered or decisions they had to make, and how they resolved them tended to score better.

Recommendations for the supervision of future candidates

- Supervisors need to help candidates direct their research towards higher level mathematical topics and make sure the student is analysing the mathematics within the essay. The most successful essays start from familiar work that is in the syllabus, and then go beyond.
- Supervisor guidance is needed most at the initial stages helping the candidates narrow down the topic to be able to concentrate on a limited area (RQ) and finding suitable research sources.
- Candidates that pitch the mathematics too high often struggle to show a clear understanding, and so score disappointingly.
- Candidates who opt for statistical essays should be encouraged to explore statistical models and their underlying assumptions as part of their work.
- Candidates need to clearly explain their mathematical work and not skip the non-trivial steps, to show understanding.
- Candidates are reminded that they must properly reference all materials. Facts that are stated or diagrams used without sources identified will be flagged for a possible breach of Academic Honesty.
- When writing the reflections, candidates are reminded to extract and discuss what they learnt during the research process, rather than merely recounting what they did.
- All candidates should be encouraged to proof-read the entire extended essay once completed and also check with the criteria to see whether all areas have been covered.
- The research question was not stated as a question in a few essays.

Further comments

- Some candidates clearly want to write about sport or music or a business venture or a CAS experience (for example) through the context of mathematics. That is fine, but candidates and schools are reminded that a Mathematics EE is judged largely on the quality of the mathematics therein. Candidates who do not want to emphasise the mathematics so much should consider World Studies for their essay.
- There is a difference between a Mathematics Extended Essay and a typical paper in a Mathematics Research Journal, and candidates should be aware of the difference. Papers in a research journal, if judged as extended essays would show no clear focus on the research question, inadequate explanations and they would fail to demonstrate a clear understanding. In particular, phrases such as 'this can be simplified to' or 'it follows that' should be avoided. Such simplifications and explanations are needed in an extended essay to show a full understanding.
- It was felt that the standard of extended essays in Mathematics continues to improve. The majority of candidates engaged with their research question and wrote an interesting essay.
- It was felt that the requirement that the RQ be written as a question, and the inclusion of the RPPF both helped candidates to do well.