



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination

Applied Mathematics

Mathematical Modelling Project
Sample Brief

Higher and Ordinary Level

100 marks

Information for Candidates, Teachers and Schools

A new specification for Leaving Certificate Applied Mathematics was introduced in September 2021 and will be examined for the first time in 2023. Assessment comprises of two elements: (1) a final written examination, and (2) a mathematical modelling project. The modelling project is worth 100 marks, which is 20% of the overall marks for Leaving Certificate Applied Mathematics. The remaining 400 marks (80%) are for the final examination.

The State Examinations Commission will annually issue a brief for the modelling project in Year 2 of the course. The brief is common to Higher and Ordinary level. All candidates (Higher and Ordinary level) are required to undertake a modelling project and to complete and submit their reports to their teachers later in Year 2, by a date specified by the Commission. Schools will subsequently submit the reports to the Commission for assessment.

The report must be presented in the digital completion booklet provided by the State Examinations Commission. This will be available for download in due course from www.examinations.ie. Candidates are not required to nominate their examination level at the time of submission of their report.

The school authority should retain securely a digital copy of each candidate's report until after results have issued and all appeal processes have been completed. This includes the reports of candidates who have not appealed.

While candidates may carry out background research relevant to the brief on their own and/or at home, all other parts of the modelling project and report must be completed under the supervision of the class teacher in accordance with the conditions set down by the State Examinations Commission as outlined in Circulars S69/04 and S68/08, which are available at www.examinations.ie. The report must be the candidate's own individual work – authenticated by the candidate, the teacher and the school management authorities. Where a report cannot be authenticated as the candidate's own work, it will not be accepted for assessment. This will result in the forfeit of the marks associated with this examination component. Any incidence of suspected copying, improper assistance from another party, plagiarism or procurement of work prepared by another party will be thoroughly investigated.

Instructions for Candidates

You must complete a modelling project and report in response to the brief outlined in this document. The modelling project brief is designed to allow you to engage in the full modelling cycle, as outlined below in *The Modelling Cycle* section of this document.

Given that the same project brief applies to Higher and Ordinary level candidates, you do not have to make a final decision on the level that you are taking when submitting your report. The State Examinations Commission will grade your project in line with the standards that apply to the level at which you take the final examination.

Your report must not exceed 900 words (excluding references, equations, diagrams, graphs, etc.). Your report must not include more than 20 images. An image can be any relevant table, graph, chart, diagram or photograph. The total file size of your digital report including all embedded images must not exceed 100 MB. Videos must not be included in your report.

Penalties may apply if you exceed the total word count or image count or file size. All secondary sources used (books, journals, websites, etc.) must be acknowledged in the report. If you include material copied directly from the internet or from other sources, and do not identify it clearly as such, this will be regarded as plagiarism.

Your report must be completed using the digital completion booklet provided by the State Examinations Commission. Any graphs, data files, diagrams, photographs, etc. must be included within the relevant sections of the booklet. Examiners will mark the digital version of the booklet only and not any other material attached or enclosed.

Your modelling project and report must be completed within the time period allocated by the State Examinations Commission.

While you can seek advice from your teacher and others in guiding you, you must carry out your work independently of other candidates and the project and the report must be your own individual work – authenticated by yourself, by your teacher and by your school management authority. Authentication is an important part of how the State Examinations Commission ensures fairness to everybody in the assessment of coursework.

Because you are completing both the modelling project and the report under teacher supervision, your teacher is able to guarantee to us that it is your own work, and that nobody gave you any inappropriate help. If you include work that was not supervised by your teacher, then they cannot authenticate it, even if they believe that you really did do it yourself. The State Examinations Commission cannot accept work for assessment if your teacher cannot authenticate it, so you will forfeit the marks for the project work. Note also that we cannot give partial marks for ‘partially authenticated’ work. That is, unless *all* of your work can be authenticated by your teacher, we cannot accept *any* of it for marking.

Any case of suspected copying, plagiarism, improper assistance or procurement of work prepared by another party will be thoroughly investigated. These actions are breaches of examination rules and attract the penalties described in the *Rules and Programme for Secondary Schools*. The penalties include: loss of the marks for the modelling project, loss of the subject, loss of the entire examination in all subjects, or being debarred from the Certificate Examinations in subsequent years. There may be serious consequences for any person who provides you with inappropriate assistance, as this is an offence under the Education Act 1998.

Responsibility for complying with examination requirements rests with you, the candidate. If the requirements are not followed, your teacher and school will have no choice but to bring this to the attention of the State Examinations Commission.

When your work is marked, assessment criteria will be applied and marks will be allocated to the various sections of the report as outlined below in the *Report Structure and Mark Allocations* section of this document.

The Modelling Cycle

The modelling project brief is designed to allow you to engage in the full modelling cycle.

Your report should show how you selected the problem(s) relevant to the brief to model, translated the problem(s) into mathematics, computed solution(s), analysed your proposed solution(s), and then iterated (repeated) this modelling process, making refinements based on your iterations before drawing conclusions.

A description of the modelling cycle is as follows:

1. Research the background to the brief so as to determine relevant information and data, and to analyse relevant factors and variables.
2. Break up the topic of the brief into manageable parts and select which problem (or problems) relevant to the brief that you intend to model. If necessary, carry out further research to determine and analyse information, data, factors and variables that are specifically relevant to the problem(s) you have selected.
3. Identify and analyse the assumptions which may be necessary to simplify the problem(s) you have selected.
4. Develop an initial mathematical model – translate the information relevant to each problem, together with any assumptions you have made, into a mathematical model.
5. Compute solution(s) to each problem using appropriate mathematical tools. Such tools may include mathematical methods you have met as part of your studies in Applied Mathematics or elsewhere. They may also include computational technologies, including numerical or graphical techniques for generating solutions.
6. Interpret your mathematical solution(s) in the context of the problem you are modelling.
7. Analyse your solution(s). Examine the sensitivity of your solution(s) to changes in assumptions. Compare your solution(s) to your previous solution(s), to solutions found in research, and/or to real-world data. Use this analysis to refine your model.
8. Iterate the modelling process. You should continue this iterative process to refine and improve your model and your solutions before you draw conclusions.
9. Present a report on your work using the digital reporting booklet provided by the State Examinations Commission, available at www.examinations.ie.

Modelling Project

Complete a mathematical modelling project and report based on the following brief:

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.

www.un.org/en/climatechange/what-is-climate-change

Select one or more aspects of climate change. Model the problem(s) you have selected using the cycle described in *The Modelling Cycle* section of this document.

Additional relevant material

The popular idea of cutting our emissions in half in ten years only gives us a fifty percent chance of staying below +1.5 °C and the risk of setting off irreversible chain reactions beyond human control. But those numbers do not include tipping points, most feedback loops, additional warming hidden by toxic air pollution or the aspects of equity and climate justice. They also rely on my generation sucking hundreds of billions of tons of your CO₂ out of the air with technologies that barely exist.

Greta Thunberg
UN Climate Action Summit, 2019



Analysis of over 100 years of observational data shows that our climate is changing. This is most evident in the temperature data and particularly over recent decades.

It is not only temperature that has changed. There have been changes in rainfall and decline in snow and ice. Sea-level has increased as the oceans also heat up.

www.epa.ie

Report Structure and Mark Allocations

Section	Indicative Content	Marks
<i>Introduction and Research</i>	<ul style="list-style-type: none"> • Background research on brief • Identify specific problem(s) to be modelled • Research specific problem(s) • Identify relevant variables • Present relevant data • Provide citations and references 	20
<i>The Modelling Process</i>	<ul style="list-style-type: none"> • Explain and justify model and assumptions • Compute solutions • Present solutions using appropriate mathematical and graphical representations • Analysis of solution(s) – sensitivity to changes in assumptions; comparison with other solutions or real-world data • Iterative process 	50
<i>Interpretation of Results</i>	<ul style="list-style-type: none"> • Interpretation of solution(s) in real-world context • Conclusions and reflections 	15
<i>Communication and Innovation</i>	<p>This is not a distinct section of the report.</p> <ul style="list-style-type: none"> • Innovative and creative approaches • Overall coherence 	15