2027L020C2EL

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2027

Applied Mathematics

Mathematical Modelling Project
Coursework 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 (SEC) 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 to be specified by the SEC. Schools will subsequently submit the reports to the SEC for assessment.

It is the responsibility of the candidate to create and manage their digital document for completing the report. The SEC provide a cover page in Microsoft Word format (.docx) and this can be downloaded from www.examinations.ie. You must complete the SEC cover page with all relevant information and it must be incorporated as the first page of your document. It is the candidate's responsibility to ensure that their report is structured and formatted according to the instructions in this brief.

Candidates are not required to nominate their examination level at the time of submission of their report.

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 full and strict compliance with the procedures and conditions outlined in this coursework brief and in the State Examinations Commission (SEC) Coursework Rules and Procedures.

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 case of suspected copying, plagiarism (which includes the use of AI software), improper assistance, or procurement of work prepared by another party will be thoroughly investigated.

The final version of the document must be converted to PDF format before it is submitted to the SEC. The candidate should carefully proof-read a copy that they have printed from the PDF file, so as to ensure that all of their work is visible. Any work that is not visible on this printed copy will likewise not be visible to examiners marking the work digitally and can therefore not gain any marks. Once this check on the quality of the PDF format has been completed, they are required to print the final version of their PDF booklet as submitted. This printed copy of the final version of the PDF booklet as submitted and the digital version of the booklet should be retained safely by the school authorities until the appeals process has been completed.

Examiners will only mark work that is submitted in accordance with the instructions in this booklet and relevant circulars.

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.

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 SEC 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.

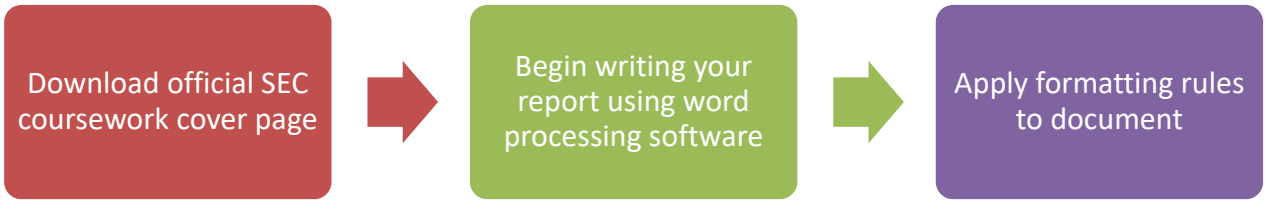
Penalties may apply if you exceed the total word count or image count or file size.

You must reference and acknowledge all research sources used, such as: publications – including books, professional journals and government reports; online sources and other types of media; any material generated using artificial intelligence (AI) software or applications; specialist organisations and relevant individuals. To include such material without properly referencing the source will be considered plagiarism. In addition, the copying from, or reproduction of, material from such sources may also be considered plagiarism.

Your report will be submitted digitally to the SEC for marking. You must complete the cover page provided by the SEC with all relevant information and it must be incorporated as the first page of your document. The SEC do not provide a submission booklet or template for the report so it is your responsibility to ensure that your report is structured and formatted according to the instructions in this brief.

The final version of the document must be converted to PDF format before it is submitted to the SEC. You may use any suitable word processing software to complete your report, provided that it has the functionality to convert the document to PDF format once completed. It is strongly recommended that you make and regularly update a backup copy of your digital report, which can be used in the event of loss or corruption.

It is your responsibility to ensure that all electronic material submitted is free from viruses etc., so that the file can be opened for assessment.



Your Mathematical Modelling Project should involve the following three sections.

1. Introduction and Research
2. The Modelling Process
3. Interpretation of Results

The report you produce must adhere to the following formatting rules:

Section headings	Each section should be numbered and appear on a new page of the report. The heading should use the following font: Arial, black, font size 14 and bold.
Main body text	Arial, black, font size 12 with 1.5 line spacing.
Text editing features permitted	Bold, italics, numbering, and bullets.
Text editing features **not** permitted	Coloured text (black text only), highlighted text, different fonts (Arial only).
Page orientation	Portrait only.
Page numbering	Bottom-centre of each page.
Page margins	Left margin 20 mm Right margin 20 mm Top margin 20 mm Bottom margin 20 mm

Any graphs, data files, diagrams, photographs, etc. must be included within your report. Examiners will mark the digital version of the report only. You are not allowed to attach or include links to any other material.

When referring in the body of the report to any specific image, the image must be properly labelled (Figure 1, Figure 2, etc.). Images should not be used as a means to include additional text. It is advisable not to use images where a person or persons in these images may be identifiable.

When you are signing off and submitting your coursework booklet, it must be converted to PDF format before being submitted through the Schools Portal. You should carefully proof-read a copy that you have printed from the PDF file, so as to ensure that all of your work is visible. Any work that is not visible on this printed copy will likewise not be visible to examiners marking the work digitally and can therefore not gain any marks. Once this check on the quality of the PDF format has been completed, you are required to print the final version of your PDF booklet as submitted. This printed copy of the final version of the PDF booklet as submitted and the digital version of the booklet should be retained safely by the school authorities until the appeals process has been completed.

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 Allocation*s section of this document.

The SEC will provide further information in relation to the appropriate file name to use and how to upload digital coursework to the Schools Portal.

Your modelling project and report must be completed within the time period allocated by the SEC. The mathematical modelling report must be completed and handed over to your class teacher by **09 April, 2027.**

Authentication

- Authentication is an important part of how the SEC ensure fairness to everybody in the assessment of coursework.
- The mathematical modelling project and report must be your own individual work – authenticated by yourself, by your teacher and by your school management authority.
- 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.
- While you may carry out background research relevant to the brief on your own and/or at home, all other parts of your project and your report must be completed under the supervision of your teacher in full and strict compliance with the procedures and conditions outlined in this coursework brief and in the State Examinations Commission (SEC) Coursework Rules and Procedures.
- Any case of suspected copying, plagiarism (which includes the use of AI software), 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 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.
- 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.
- Teachers and the authorities of schools are familiar with the detailed requirements to ensure that practical and project work is valid for examination purposes. You should comply fully with all requests that are made by the teacher and the school in order to enable authentication of your work.

Note: 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.

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.

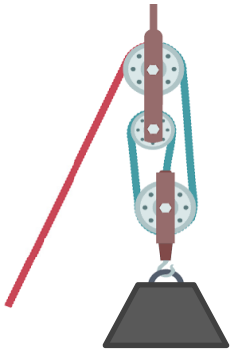
7. Analyse your solution(s). Examine the sensitivity of your solution(s) to changes in assumptions. Compare your solution(s) to your previous solution(s), to solutions found in research, and/or to real-world data. Use this analysis to refine your model.

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. Make sure to use the cover page provided by the SEC, available at www.examinations.ie.

Modelling Project

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



Pulleys are devices that may be used to change the direction or magnitude of a force that is required to move a system of connected masses. Pulley systems may combine a series of pulleys that are arranged in a particular order to perform a given function. The pulleys used may be fixed or moveable, or a combination of both fixed and moveable, depending on what the system is designed to perform.

Understanding the factors that affect how a system of connected masses interact is essential for predicting the motion of the system.

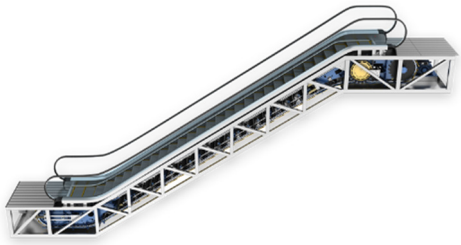
These factors include (but are not limited to):

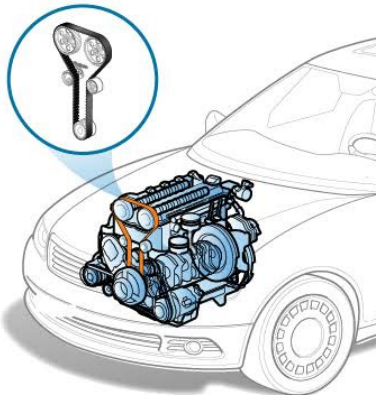
- *the arrangement of the system*
- *the mass of the components used*
- *the elasticity of the components used*
- *the force(s) applied*
- *the interaction with external force(s)*
- *the work done*

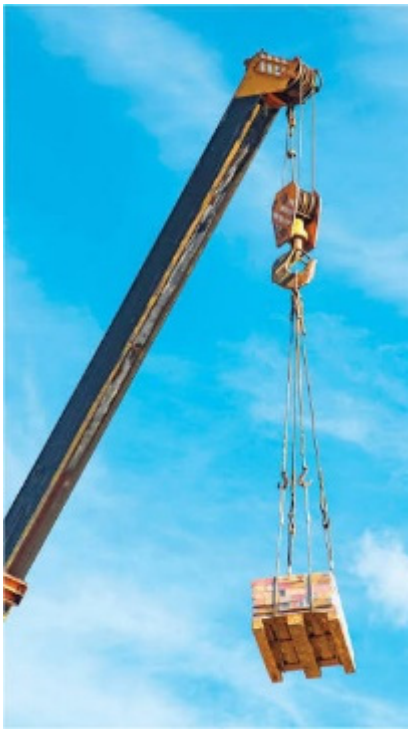


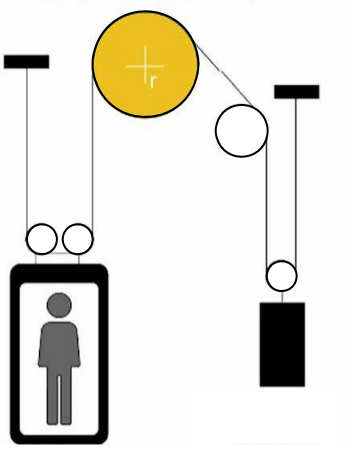


Select one or more aspects of a connected mass system involving pulleys that is used in the physical world. Model the problem(s) you have selected using the cycle described in *The Modelling Cycle* section of this document.









Images
nationalgeographic.org
elevatorworld.com
againfaster.eu
bbc.co.uk
eol.group
koyocn.com
autobaak.nl

Report Structure and Mark Allocations

Section	**Indicative Content**	**Marks**
Introduction and Research	• 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**
The Modelling Process	• 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**
Interpretation of Results	• Interpretation of solution(s) in real-world context • Conclusions and reflections	**15**
Communication and Innovation	This is not a distinct section of the report. • Innovative and creative approaches • Overall coherence	**15**