Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION 2006

ENGINEERING

ORDINARY LEVEL CHIEF EXAMINER'S REPORT

HIGHER LEVEL CHIEF EXAMINER'S REPORT

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Engineering Examination 2006

1. General Introduction

1.1 The Syllabus

The present Leaving Certificate Engineering syllabus was introduced to the Senior Cycle curriculum in 1984, and was first examined in 1985. This current syllabus is examined at two levels – Ordinary level and Higher level. A new syllabus developed by the NCCA, titled Engineering Technology, awaits implementation and is to replace the current syllabus in Engineering.

1.2 The Examination

The examination, at both Ordinary and Higher levels, comprises three components as follows:

(i) Technology Project

(ii) Practical examination

(iii) Written examination.

All candidates, at both Ordinary and Higher levels, are required to attempt all three components.

The examination format and mark allocation for each component are outlined below in Table 1.

ENGINEERING	
EXAMINATION	**MARKS**
Higher Level	
Technology Project: Design	150
Practical examination	150
Written examination (Materials and Technology)	300
TOTAL	600
Ordinary Level	
Technology Project: Manufacture	150
Practical examination	150
Written examination(Materials and Technology)	200
TOTAL	500

Table 1: Leaving Certificate Engineering examination format

1.2.1 The Technology Project

Each candidate, at both Ordinary and Higher level, is required to submit an artefact and a design folio based on a project brief issued by the State Examinations Commission (SEC). The project briefs, accompanied by a detailed marking scheme, are issued by the SEC in

October of year two of the Leaving Certificate programme, and the project has to be completed by the following March. All project work must be the candidates own individual work, carried out under the supervision of the class teacher. At Higher Level the candidates own individual work is intended to include the intellectual activity of design, along with the practical activities of making the artefact and compiling a design folio. At Ordinary Level, the candidates own individual work is intended to include the practical activities of making the model from the given drawing or according to a comparable alternative design, and compiling a design folio. On completion, all project work is securely stored by the relevant school authority until June, when it is laid out in the school, and marked by a team of visiting examiners who are appointed and trained by the SEC.

1.2.1 The Practical Examination

The Practical examination is a six-hour test which takes place in the school, under examination conditions, in early May. Candidates take this component at a Common level. Lists of required equipment and specified materials are sent by the SEC to the schools in October, along with drawings and specifications for parts which each candidate is required to make prior to the examination. The examination paper for the Practical examination requires candidates to interpreting a drawing, and mark out, process, finish and assemble an artefact. On completion of this examination, all test artefacts are sent to the SEC headquarters in Athlone where they are marked by a team of examiners appointed and trained by the SEC.

1.2.3 The Written Examination

The written examination which is offered at two levels, Ordinary and Higher, takes place in June and is marked by examiners appointed and trained by the SEC.

Ordinary Level

The written examination at Ordinary Level is of 2.5 hours duration and consists of a total of seven questions. Candidates are required to answer Question 1, Sections A and B and select three other questions from the remaining six.

Higher Level

The written examination at Higher Level is of three hours duration and consists of a total of eight questions. Candidates are required to answer Question 1, Sections A and B and answer four other questions from the remaining seven.

1.2.4 Weightings and Mark Allocations

Ordinary Level

The written examination represents 40% of the examination, while the project and the practical examination represent 30% respectively. This weighting is reflected in the mark allocation for each component. The following table and chart show the weighting and mark allocation for each component:

Written	Project	Practical	Total
200 marks	150 marks	150marks	500

Table 2: Allocation of marks - Ordinary Level

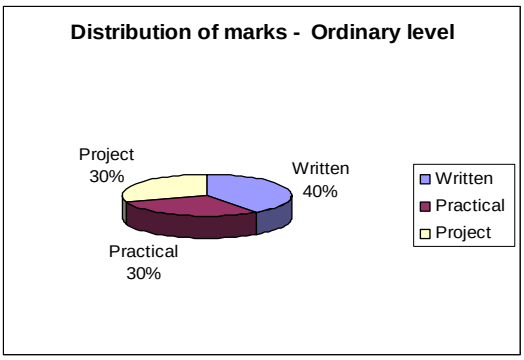

Table 3: Weightings - Ordinary Level

Higher Level

The written examination represents 50% of the examination, while the project and the practical examination represent 25% respectively. The following table and chart show the weighting and mark allocation for each component:

Written	Project	Practical	Total
300 marks	150 marks	150marks	600

Table 4: Allocation of marks - Higher Level

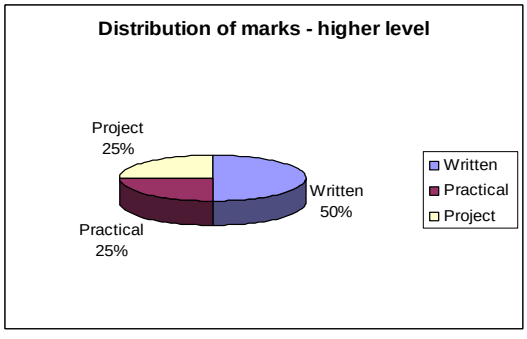

Table 5: Weightings - Higher Level

1.3 Candidature

The number and percentage of candidates taking Engineering from the full Leaving Certificate candidature is represented in Table 6 below. The number of candidates taking Engineering has remained relatively constant from 2004 to 2006.

Year	Full cohort of Leaving Certificate candidates	Engineering	Percentage of cohort
2004	55222	4945	9.0%
2005	56237	4891	8.7%
2006	54110	4775	8.8%

Table 6: Number and percentage of candidates taking Engineering from the full Leaving Certificate Cohort 2004 – 2006

Table 7 shows the number of candidates taking Engineering at Higher and Ordinary levels from 2004 to 2006. The numbers taking Higher Level have remained consistently high with approximately 70% of the total candidature opting for this level each year. Slightly less than 30% of Engineering students opted for Ordinary Level over the past three years.

Year	Total	Higher Level		Ordinary Level	
		Candidature	%	Candidature	%
2004	4945	3501	70.8	1444	29.2
2005	4891	3435	70.2	1456	29.8
2006	4775	3439	72.0	1336	28.0

Table 7: Number and percentage of candidates taking Engineering at Higher and Ordinary levels 2004 - 2006

2. Performance of Candidates.

2.1 Performance of candidates at Ordinary Level

The overall performance of candidates at Ordinary Level over the past four years is shown in Table 8 below. The table shows the percentage of candidates achieving each grade when marks for each of the three examination components are combined

	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	1469	3.0	20.7	39.7	63.4	28.4	6.4	1.6	0.2	8.2
2004	1444	2.8	26.4	42.1	71.3	23.4	3.8	1.4	0.0	5.2
2005	1456	3.1	27.9	40.6	71.6	21.6	5.4	1.2	0.0	6.6
2006	1336	3.2	24.8	39.3	67.3	24.6	6.4	1.6	0.0	8.0

Table 8: Percentage breakdown of candidates achieving each grade at Ordinary Level 2003 – 2006

The percentage of candidates achieving the A grade has remained relatively static since 2003. However, 67.3% of candidates achieved grade C or higher in 2006. This represents a decrease of approximately 4% when compared to the mean of the combined A, B and C grades for 2005 and 2004. This decrease occurs primarily in the number of candidates achieving the B grade and is distributed between those achieving the D grade which has increased by 3% and the combined E/F/NG grades which increased by 1.4%.

2.1 Performance of candidates at Higher Level

The overall performance of candidates at Higher Level over the past four years is shown in Table 9 below. The table shows the percentage of candidates achieving each grade when marks for each of the three examination components are combined.

	TOTAL	A	B	C	ABC	D	E	F	NG	EFNG
2003	3520	8.9	31.4	36.2	76.5	19.8	3.4	0.5	0.0	3.9
2004	3501	7.9	30.4	35.6	73.9	21.9	3.8	0.5	0.0	4.3
2005	3435	10.6	31.1	34.0	75.7	20.3	3.5	0.5	0.0	4.0
2006	3439	10.1	31.8	33.1	75.0	20.7	3.7	0.7	0.0	4.4

Table 9: Percentage breakdown of candidates achieving each grade at Higher level 2003 – 2006

The percentage of candidates achieving an A grade has risen slightly from 2003 to 2005 and has remained constant, at approximately 10%, in 2005 and 2006. Three quarters of the cohort at this level have consistently achieved grade C or higher. The combined E/F/NG grades in 2006, at 4.4%, is very much in line with the mean of the E/F/NG grades

obtained from 2003 to 2005. This low failure rate combined with the percentages achieving the A, B, and C grades show candidates are performing consistently very well at Higher Level.

3. Technology Project

3.1 Introduction

The Technology Project was submitted for examination by a total of 4,731 candidates in 2006. 3,737 candidates submitted the project at Higher Level while 994 projects were submitted at Ordinary Level. As stated previously, candidates are required to submit an artefact and a design folio at both Ordinary and Higher levels. All project work must be the candidates' own individual work, carried out under the supervision of the class teacher. Project work accounts for 25% of the overall total at Higher Level and 30% of the overall total at Ordinary Level.

Projects were marked by application of the marking scheme which was issued with the project briefs by the SEC in October 2005. Examiners commenced the marking process in schools on Tuesday June 6th and it was completed on Friday June 16th 2006. The work of each examiner was monitored by an advising examiner during the marking process in order to ensure accuracy in marking and inter-rater reliability.

Project briefs for the Technology Project are designed to support the primary aims of the Leaving Certificate Engineering Syllabus, one of which is to "to promote initiative in the planning and development of technological projects". In this context and in general, examiners reported favourably on the nature and the level of the candidate's solutions to the given briefs. Examiners noted the display and diversity of design skills in many centres, including creativity, innovation and problem solving. They also commented on the high quality of practical skills exhibited by candidates in project artefacts which were manufactured using a wide variety of engineering processes. However, it was also reported that in a small number of centres, the skill level and quality of work varied greatly. The standard of presentation of the folio was reported as excellent in many centres. In a minority of centres, there is still cause for concern in relation to the standard of finish and presentation of both the artefact and folio.

Examiners noted that in most centres teachers and candidates put considerable effort into the layout and presentation of both the artefact and the folio. Some centres provided dedicated display stands to enhance presentation. Such an effort is to be commended as it

values the effort of the candidates and offers a showcase within the school for the creativity and skills of the candidates. In a small number of centres, projects were presented in an untidy and cluttered manner.

3.2 Performance of candidates at Ordinary Level

The Ordinary level Engineering Project has a mark allocation of 150 marks which equates to 30% of the overall marks for the subject at this level. A total of 994 candidates presented projects at Ordinary level this year; this represents a reduction of 266 candidates when compared with the number of candidates who submitted project work at this level in 2005.

A summary of the statistics for this year and recent years is presented in Table 11 below.

Year	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	1160	15.3	28.5	28.7	72.5	17.0	7.1	2.5	1.0	10.5
2004	1165	21.2	32.3	27.1	80.6	14.8	3.5	0.9	0.3	4.6
2005	1260	29.4	34.5	20.4	84.3	9.0	4.9	1.5	0.2	6.7
2006	994	21.9	30.8	23.7	76.5	12.0	5.7	5.5	0.3	11.6

Table 11: Candidate performance Ordinary Level project 2003 – 2006

The percentage of the cohort achieving an A grade in 2006 is significantly down on 2005 but is in line with previous years. The percentage of candidates achieving a B or C grade has remained in line with recent years. Some examiners reported very poor work in specific centres and this is reflected in the increase in the F grade which in turn has increased the combined E/F/NG grade by a disappointing 4.9% from 2005. Furthermore, a survey of a random sample of 38.2% of all projects marked at this level, shows that 17.1% of candidates failed to submit a folio. This will also have contributed to the increase in the combined E/F/NG grades.

The overall decrease in the percentage of the cohort submitting work at Ordinary Level may also have contributed to the disappointing overall performance at this level in 2006 compared with recent years.

3.3 Performance of candidates at Higher Level

The Engineering Project at Higher Level has a mark allocation of 150 marks; this equates with 25% of the total marks at this level. A total of 3737 candidates presented projects at Higher Level this year. This represents an increase of 131 candidates when compared with the number of candidates who presented projects in 2005.

Table 10 illustrates the grade distribution for the Higher Level project for the years 2003 – 2006.

Year	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	3733	19.6	29.8	26.3	75.8	16.1	5.7	2.2	0.2	8.1
2004	3754	21.9	40.0	24.7	86.7	9.9	2.7	0.7	0.1	3.4
2005	3606	22.4	29.1	24.7	76.2	15.5	5.9	2.1	0.2	8.3
2006	3737	22.5	34.2	25.3	82.0	11.9	4.3	1.7	0.2	6.2

Table 10: Candidate performance Higher Level project 2003 – 2006

The grade profile of the final results is generally in line with those of recent years. The percentage of candidates achieving the A grade has marginally increased over the past three years from 21.9% in 2004, to 22.4% in 2005 and 22.5% in 2006. This increase is welcomed, along with a 5.1% increase in the B grade from 2005. The combined A, B and C grades show an increase on last year with four out of five candidates achieving grade C or higher. The combined E/F/NG grade has decreased by 2.1% from 2005; this is a satisfactory trend as it had increased by 4.9% from 2004 to 2005.

Examiners reported that in many centres candidates showed high levels of skill and accuracy in the design and realisation of the project.

3.4 Analysis of Candidate Performance at Ordinary Level

Candidate responses to the project brief for Ordinary Level produced solutions from excellent to very weak. Successful candidates availed of the opportunity to demonstrate their bench and manufacturing skills to great effect, producing well thought-out, perfectly assembled and functioning artefacts, with high levels of accuracy and finish inherent.

Examiners also reported some very poor work, often confined to specific centres, in both the artefact and the folio and, in some cases, the folio was either not presented or not fully completed.

3.4.1 The Artefact (110 marks)

In order to satisfy the project brief each candidate had to:

Make a **Model Fork-Lift Truck** according to the example shown or according to an alternative design. The brief also included the following specifications.

(a) Using appropriate materials make the model according to your plans which should include:

  (i) An electrical drive for the **Truck** with an LED in the circuit;

  (ii) Operation of the **Truck** by means of an ON/OFF switch.

(b) **The use of bought-in electronic solutions will result in lost marks**.

(c) All main operating features of the completed model to be **clearly visible without dismantling**.

(d) The longest dimension should not exceed **200 mm**.

(e) Electric power should not exceed **9 volts**.

Make a Model Fork-Lift Truck according to the example shown or according to an alternative design.

The majority of candidates followed the issued drawing, many incorporated additional designs or alterations to specific parts in their manufactured solution. However, there were some excellent artefacts produced from some innovative alternative designs, some incorporating a lifting mechanism for vertical movement of the forks. The more successful solutions were characterised by good finish, proportion and stability. Examiners also reported work which was weak with poor skill levels and finish. There were also difficulties in specific cases with proportion and lack of attention to safety, and examiners reported many cases where the seat and steering wheel were omitted.

Materials selected were generally appropriate with aluminium, acrylic and mild steel the popular choices.

An electrical drive for the truck with an LED in the circuit

The predominant electrical drives used were: motor and pulley, gear box, and worm gear systems. Some candidates encountered problems with blown LEDs; however, examiners awarded the full allocated marks for this element of the artefact if the circuit was assembled properly. As with some of the Higher Level candidates, examiners noted a failure on the part of some candidates to pay adequate attention to safe and neat wiring in the construction of basic electronic circuits. In a minority of cases, candidates neglected or failed to assemble the electronic circuit, often presenting the project with the supplied circuit components lying next to the artefact. Candidates should be provided with an opportunity to practice making and assembling these circuits prior to beginning the Leaving Certificate Project.

Operation of the Truck by means of an ON/OFF switch.

Candidates who attempted the electrical drive for the Truck had no problems with this specification.

Constraints**: **clearly visible,** not exceeding **200 mm** and not exceeding **9 volts

In the vast majority of completed artefacts all of the specified constraints were observed.

3.4.2 The Folio (40 marks)

The folio records the work of the candidate and should contain all the details of the project work. Candidates are given clear instructions in the design brief, under the heading Planning and Organisation, regarding the compilation of the folio. These are further reinforced in the Marking Scheme under *Marking Criteria – Folio*. At this level, the folio was generally the weakest part of the project work presented and many candidates achieved low scores for the folio.

Some candidates followed the format of the Higher Level folio and consequently did not satisfy the project brief for Ordinary Level. Teachers are advised to guide candidates in relation to the appropriate folio format for their level.

- Of particular concern is the very significant number of candidates who failed to submit a folio. An analysis of a random sample of 38.2% of projects marked at this level (380 projects), showed that 17.1% of candidates (65 candidates) failed to submit a folio. This trend is reflected in the combined E/F/NG of 11.6% for the Ordinary Level project. It is recommended that teachers encourage candidates to complete all aspects of each examination component and to develop the folio in tandem with the development of the artefact

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Candidates who were most successful had carefully read the project brief and followed the directions therein. Their folios comprised a concise compilation detailing all aspects of their work, which included the following sections:

- **Planning details** required before undertaking the task or alternative design details;
- **Parts list** and **working drawings**;
- Organisational plan, indicating the **manufacturing processes**, **materials and finishing treatments** to be used;
- **Testing and evaluation** of the finished model including special instructions, if necessary, regarding the testing of the model by an examiner.

The following are some of the observations reported by examiners in relation these sections in the folio:

- Planning details / alternative designs – in this section, successful candidates clearly outlined their intentions regarding the solution they wished to manufacture. Some candidates, who used an alternative design or a variation on the given drawing, did not clearly demonstrate and provide details regarding their alterations / alternative designs.
- The standard of working drawings varied significantly and some candidates failed to present dimensioned drawings.
- Candidates need to learn how to compile a work plan for the manufacture for the artefact. This aspect of project / time management, if addressed, will enhance the quality of the finished artefact. In the work plan, candidates must identify the processes and procedures undertaken to manufacture the artefact.
- Finishing treatments were the most neglected section of the folio. Candidates should pay particular attention to this area as not only will this result in additional

marks for the folio but, if knowledge is applied, the overall quality of the artefact will also be improved.

- Testing and / or evaluation were often left out of the folio, resulting in lost marks.

3.5 Analysis of Candidate Performance at Higher Level

The project brief for Higher Level was well received by candidates and teachers and was deemed to be a fair but challenging test. The scope of the brief was highlighted by the diversity of the projects presented. Marking progressed smoothly with examiners reporting the quality of the project artefacts and folios comparable with recent years. A successful working crushing device demanded a robust structure in order to function effectively. The more successful candidates displayed an excellent understanding of lever laws and forces incorporating effective designs. Their artefacts and folios reflected a thorough understanding of the design process with creativity, inventiveness and excellent manufacturing skills in evidence.

Project management is crucial towards a successful outcome in this examination component, especially when constrained by time and by elements of the brief. It was evident from the folios of many candidates that a structured process had been implemented. This involved analysing the brief, brainstorming, investigating a number of possible solutions, mock up or modelling solutions, selecting a final solution, using a manufacturing plan from well-produced working drawings, and testing and evaluating continuously throughout the process.

3.5.1 The Artefact (110 marks)

A successful final solution required the following:

- a **can crushing device**, manually operated or controlled by an ON/OFF switch, which will crush an average soft drinks can
- an **electronic indicator** to signal the end of the crushing operation
- a means to **eject and guide** the crushed cans to a suitable receiver

The final design also had to incorporate the following **constraints**:

(a) All main operating features to be **clearly visible without dismantling**.

(b) The longest dimension of the device not to exceed **300mm**.

(c) Electric power does not to exceed **9 volts**.

Examiners reported that the quality of the response to the challenges presented in the design brief varied, from excellent to average, between centres and very often within individual centres.

A can crushing device**.....**

The most popular solution was a manually operated, lever-type can crushing device. In this type of system, the movement was usually produced by some form of linkage which magnified the force exerted by the lever / handle. Other mechanisms used included, screw operated systems (a small percentage of these were motorised), crank and piston, foot operated devices and gear systems. Some candidates presented solutions using pneumatics and hydraulic rams in the crushing operation.

It was also evident that, while some candidates had excellent ideas, they did not have the necessary practical skills or project management skills to realise their solutions. Other candidates had difficulty in getting the crushing mechanism to operate smoothly and other aspects of their solution suffered as a result of this. It is noteworthy that some candidates referred to their difficulties in the Evaluation section of their folios. This is good practice as it is evidence of a level of awareness and understanding on the part of the candidate and it assists the examiner when allocating marks to specific areas of the Marking Scheme.

Include an electronic indicator…..

In most solutions the end of crushing was indicated by a LED or buzzer which is activated by the crushed can contacting a PMT switch or a lever switch. This type of electronic solution, which is based on simple / basic electronics, satisfied the brief adequately. Many excellent designs were evident which incorporated the electronic indicator as part of the overall can crushing process. However, examiners reported some instances where candidates disappointed in their attempts to satisfy this element of the design brief. The main area of concern was the failure to pay adequate attention to safe and neat wiring in the construction of basic electronic circuits. Examiners also reported that, for some lower

achieving candidates, often in specific centres, this part of the design brief was dealt with as an after thought, rather than as an integral part of the project. This resulted in poor placement, or housing, of the electronic circuit / components, with loose wiring and poor soldering also evident. This may have resulted in some lost marks under the headings of Suitability of Assembly Techniques, Safety Considerations and Quality of Work.

Candidates, on analysing the brief, must account for all specified elements as they progress towards a final solution.

To eject and guide the crushed cans…..

There was a varied response to this section of the design brief. Some solutions were well thought out, simple in their design and realisation, but creative and inventive and excellently incorporated as part of the overall final artefact in terms of function, proportion and stability. Ejection systems included push rods (some spring loaded), trap-door, pneumatic pistons, hinged flips, openings where gravity provided the guidance, and pendulums.

As with the electronic indicator, some candidates neglected to give this element the required attention, resulting in a loss of marks. This, along with all aspects of the design brief, must be addressed in the early stages of the design process by thoroughly interrogating the brief using such strategies as brainstorming, class discussions, and, as previously stated, using a well structured project management plan.

Constraints: clearly visible, *not exceeding* ***300 mm*** *and not exceeding* ***9 volts***

Examiners reported very high levels of compliance with all constraints inherent in the brief.

Other Observations on the Artefact

- **Materials:** The predominant materials used were aluminium, mild steel and some brass. Materials used were generally appropriate and of sufficient strength. Acrylic was used by a minority of candidates and in some instances it was not used to good effect.

- **Assembly:** Examiners reported a varied spectrum of mechanical and thermal joining techniques. Proper execution of these techniques and skills were essential towards the smooth and efficient functioning of the can crushing device. Some excellent work was evident, particularly in the joining of non-ferrous metals, where countersunk screws, nyloc and cap nuts were widely used, enhancing the final outcome. There was also evidence of some crude assembly especially where mild steel was used and arc welding of varying standards was employed resulting in a very poor finish in some instances.

  Specific centres displayed high levels of thermal joining skills associated with the joining of both ferrous and non-ferrous metals.

- **Manufacturing Skills:** It was very evident in many centres that the essential practical engineering skills were used to good effect in the manufacture of artefacts. High standards of accuracy and finish are of paramount importance in producing an artefact and candidates' executions of these were evident and welcomed.

  In many centres a wide variety of bench and manufacturing skills were employed and standards ranged from fair to excellent. Amongst the many processes employed, in the manufacture of artefacts, were lathe work, drilling, milling, vacuum forming, a variety of joining techniques as discussed above, electronics and pneumatics. It was also reported that in some centres, candidates had access to a limited range of manufacturing processes and materials and this may have inhibited them towards the realisation of a very good design solution.

- **Finish and Presentation:** Finish and Presentation are vital components in a successfully completed artefact. Marks were awarded where the candidate paid particular attention to the finishing of individual components that make up the artefact, and the overall finish and presentation of the artefact. High quality finishes may significantly improve the efficiency in movement, the potential for accurate assembly and the aesthetic appearance of the component as well as contributing to the overall presentation of the complete artefact. Examiners reported standards of finish and presentation ranging from very high quality to very poor. Examiners also reported that marks were lost by candidates who paid

insufficient attention to finish or fine detail, and, for example, left set-screws excessively long and occasionally unsafe with sharp edges prominent.

- **Unnecessary recycling:** The use of bought in parts / existing manufactured solutions was not prevalent this year. In a small number of cases candidates incorporated commercially available can crushing products, and were penalised accordingly.

3.5.2 The Folio (40 marks)

The folio provides a record of the work of the candidate and should contain all the details of the project work from the initial ideas to the final evaluation. Candidates are given clear instructions in the design brief, under the heading Design Process, regarding the compilation of the folio. These are further reinforced in the Marking Scheme under Marking Criteria – Folio. While many candidates produced excellent folios in terms of content and presentation, examiners reported that a significant percentage of folios were poor and there were areas of common weaknesses. Areas such as 'Analysis of the Given Brief' and 'Criteria for Selection of your own Individual Solution' proved the most problematic and resulted in valuable marks being lost, sometimes by candidates with excellent artefacts.

An analysis of a random sample of 39.4% of projects marked at this level (1494 projects), showed that 68 candidates (4.6%) failed to submit a folio. This is a disappointing trend, obviously resulting in lower grades for these candidates. This issue needs to be addressed from the outset i.e. when candidates are issued with the design brief in October. Candidates should, at least, complete: 1. Analysis of the design brief; 2. Investigation of possible solutions; 3. Production Drawings; before commencing the realisation of the final solution.

Some candidates have difficulties in understanding what is expected at each stage of the design process and the overall concept of project management. It would be beneficial to candidates if teachers took specific time, prior to the issue of the design brief, to guide candidates through the design process as part of a practical course work assignment. It is

also recommended that candidates pay more attention to the General directions to candidates and the Marking Scheme which are included as part of the Engineering Project examination paper.

The Design Folio must include the following sections:

Analysis of the given brief – In this section, candidates are asked to read the given design brief, highlight all the criteria and constraints demanded from the brief, and elaborate briefly on each using words, sketches, diagrams or a combination of these. This is to demonstrate that they fully understand all the challenges that have to be addressed to produce the final design of the candidates own individual solution.

Examiners reported that some candidates merely reproduced the exact wording from the issued design brief and failed to elaborate on any of the specified criteria. Candidates also confused analysis with investigation of possible solutions. Teacher guidance in facilitating the analysis process is essential here as this is the first stage of the design process and candidates need time for brainstorming and discussions in order to be absolutely clear in relation to all the requirements and specifications demanded in the design brief.

Investigation of possible solutions – For this section, candidates are required to develop at least three potential solutions (one of which may become the final solution) to the main challenges of the design brief. Different candidates used a variety of successful approaches in the development of these potential solutions. For example, some produced three complete solutions satisfying all criteria and specifications in the design brief. Others took individual criteria or specifications from the brief e.g. 'Eject and guide the crushed cans to a suitable receiver', and produced three potential solutions to this element of the design brief. They then proceeded to select the most suitable solution for each individual element and combined these to arrive at a successful final design solution. The candidates who were most successful used clear sketches, diagrams and often models to arrive at a final solution. The use of models provides the candidate with a clearer picture as to what can or cannot be manufactured and also gives an early indication regarding the size and proportion for the final design. All models are part of the design process and should be presented with the artefact and folio, clearly identified with the candidate's examination number.

Examiners reported that candidates in some centres included superfluous material in their folios. For example information on recycling and manufacture of aluminium cans, often printed directly from the internet, or description of tools and machinery, were included in this section of the folio. The internet can be a very useful resource, but candidates must show evidence of analysis or reflective thought.

Criteria for selection of solution – Under this heading candidates are required to present a justification for the final solution selected. This is a higher-order skill and the teacher's role is pivotal in developing this prior to the beginning of project work. The candidates who were most successful presented reasons why their individual solution satisfied the design brief. Some included a discussion on the merits of the selected final solution as compared to the other possible solutions in terms of satisfying all criteria and specifications of the design brief.

Production drawings/plans – Good quality dimensioned drawings from which the final solution can be manufactured are necessary here. A manufacturing plan identifying how the solution was manufactured and the procedure/processes used can be used to complement the Drawings. Some candidate used CAD to great effect in this section including both 2D and 3D presentations.

Testing and Evaluation – Under this section candidates should ask themselves the question 'does the manufactured final solution satisfy the brief'? Many candidates tested the final solution in terms of satisfying all specifications of the design brief and gave a brief account of each test. In some instances, the evaluation process saw candidates further critiquing the finished artefact, outlining its attributes and shortcomings and stating any amendments or improvements that could be made.

Presentation of the Folio – Marks are allocated to presentation of the folio and consequently much time and energy is often devoted to the development of the folio. The folio provides an ideal opportunity for the integration of ICT and many candidates integrated ICT very successfully into the folio / report and this is to be commended. Many candidates included digital images as an ongoing record of work in progress, some

candidates included drawing in 2D and 3D CAD and a significant number of candidates provided typed folios. Teachers are to be commended for leading these developments.

3.6 Conclusions

- In many instances candidates and teachers are to be commended for the display and diversity of design skills, including creativity, innovation and problem solving.

- Many candidates also demonstrated excellent practical skills producing project artefacts which were manufactured to very high standards.

- Some candidates managed their time poorly and thus spent an excessive amount of time on manufacturing the project leaving the folio as a rushed and incomplete after thought.

- At both Higher and Ordinary levels, some candidates failed to pay adequate attention to safe and neat wiring in construction of basic electronic circuits. This part of the design brief appeared not to be taken seriously and resulted in poor placement or housing of the electronic circuit/components, battery, loose wiring and poor soldering.

- The quality of the folios submitted was very high in many instances and it was evident that many candidates devoted much time and energy to the development of the folio. However, some candidates who presented very good practical work, paid little attention to the folio and thus lost a significant amount of marks.

- In the Higher Level folio the sections, *'Analysis of the Given Brief'* and *'Criteria for Selection of your own Individual Solution'* proved the most problematic, and resulted in valuable marks being lost, sometimes by candidates with excellent artefacts.

- At Ordinary Level, the folio was frequently the weakest part of the project work presented. The folios showed little evidence of planning, working drawings were

often without dimensions and details or lists of finishes or treatments were frequently omitted

- A significant proportion of candidates failed to submit a folio. This is a serious concern, especially at Ordinary Level, where there is an apparent lack of interest in attempting this prescribed element of the Project.

- The SEC acknowledges the assistance of the Engineering teachers and the school authorities in the preparation and layout of centres for marking the projects.

3.7 Recommendations to Teachers and Students

It is recommended that teachers:

- provide candidates with frequent opportunities to engage with the design process over the two years of study leading to the examination

- familiarise students with the requirements of past design briefs and marking schemes and provide them with frequent opportunities to apply the manufacturing processes and assessment criteria to coursework over the two years of study leading to the examination

- ensure that all examination candidates have a copy of the issued Design Brief and that they fully understand all *General Directions to Candidates*, criteria for assessment and the Marking Scheme

- guide candidates in planning their work in advance and in devising a project management log or Gantt chart to help them set targets and thus help optimise the use of time spend on project work

- advise candidates to develop the folio in tandem with the development of the artefact

- guide candidates in relation to the appropriate folio format for their level

- encourage candidates to compile the folio following the relevant headings in the design brief pertaining to the level at which they are submitting project work

- encourage candidates to explore a wide variety of possible solutions before they decide on their individual final solution

- encourage candidates to develop the range of investigative and research skills

- guide candidates in developing higher order skills of analysis and evaluation

- display the relevant posters relating to project work in the Engineering room and bring to the attention of all candidates the regulations contained in the relevant circulars and posters

- ensure that all candidates complete and sign the necessary documentation prior to leaving the school

- securely store all project work on completion and arrange layout in ascending numerical order for the visiting examiner.

It is recommended that students:

- read the *General Directions to Candidates* issued by the Commission with the Design Brief, and follow these in the development and execution of their project work

- ensure that they are familiar with the Marking Scheme and the criteria for assessment

- manage their time carefully so that they do not spend an excessive amount of time on project work, at the expense of the theory component

- keep a project management log, or Gantt chart, detailing target dates set for project work and recording the work completed by each target date

- develop their folio in tandem with the artefact and ensure that the folio contains a complete contemporaneous record of work-in-progress

- compile a folio following the relevant headings in the design brief relevant to the level at which they are submitting project work

- avoid the inclusion of superfluous material in the folio, such as description of tools and machinery

- show evidence of analysis or reflective thought if including material downloaded from the internet in the folio

- integrate the use of ICT in the development of the folio to enhance its content and presentation

- ensure the individual final solution provides an opportunity to demonstrate a diversity of design skills, practical skills and engineering processes

- pay particular attention to the finishing of individual components that make up the artefact as well as the overall finish and presentation of the artefact

- display the completed project work – artefact and folio – in a neat and attractive manner clearly identified with the relevant examination number.

4. The Practical Examination

4.1 Introduction

The Practical Examination consists of interpreting a drawing, marking out, processing, finishing and assembling an artefact to a given specification according to the examination paper issued by the SEC. This examination, which is of 6 hours duration (taken in two 3 hour sessions), takes place in schools in May. On completion of this examination, all test artefacts are sent to the SEC, Athlone where they are marked centrally by a team of examiners appointed and trained by the SEC. The Practical Examination which is offered at a Common level only, represents 25% of the Engineering examination and has a mark allocation of 150 marks.

A total of 4748 candidates presented for the Practical examination in 2006.

4.2 Performance of Candidates

The accompanying table and graph show the percentage of candidates achieving each grade in the Practical Examination for the years 2003 to 2006.

Year	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	4964	16.6	47.4	26.7	90.7	7.3	1.6	0.4	0.0	2.0
2004	4926	16.9	42.8	27.7	87.4	9.5	2.5	0.6	0.0	3.1
2005	4891	18.0	43.3	27.2	88.4	9.7	1.8	0.1	0.0	1.9
2006	4748	16.8	43.2	28.3	88.2	9.2	2.2	0.3	0.0	2.5

Table 12: Candidate Performance in the Practical examination 2003 – 2006

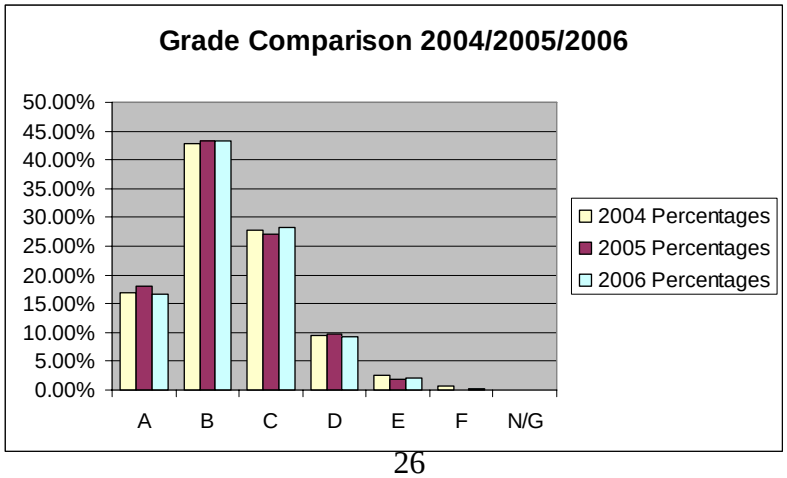
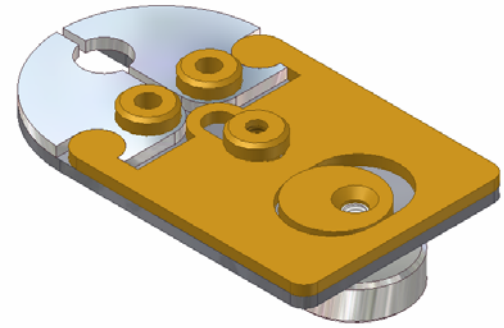


Table 13: Grade distribution in the Practical examination 2003 – 2006

The grade profile of the final results is very much in line with those of recent years. The results show a slight reduction of 1.2% in the A grades when compared with 2005 results. However, a total of 88.2% of candidates achieve a C grade or higher, which correlates very closely with 88.4% in 2005. The combined E/F/NG grades show a minor increase of less than 1%, again very comparable with recent years. This resulted in 97.5% of candidates achieving a D grade or higher in 2006.

4.3 Analysis of Candidate Performance

The purpose of this examination is to assess the practical engineering skills that the student has acquired over the two-year senior cycle programme. This year's examination, titled *model Clamp* ***mechanism*** *assembly*, was similar in style and format to previous years. One of the primary aims of the Leaving Certificate Engineering Syllabus is to promote "the acquisition of manipulative skills and techniques necessary for practical resourcefulness". Examiners, generally, reported favourably on the level of the candidates' achievement of this aim.



Examiners also reported that the examination provided ample opportunity for candidates to demonstrate skills in precision filing, drilling, fitting and accuracy within a time constraint, using a good range of materials. The test was relatively straightforward to mark out with no hidden difficulties. It required a high degree of accuracy in order to function properly and allow candidates to attain a high grade. Most candidates completed the examination in the allocated time, with some excellent fully-functional models produced to a very high degree of accuracy and finish. However, examiners reported that,

candidates who achieved lower scores found the accuracy and detail required challenging. The vast majority of candidates had sufficient time to fit, assemble and polish their test artefacts thus maximising their marks.

Preparation of Blanks:

The preparation of the pre-finished parts/blanks was generally quite good. In a small number of centres, black mild steel blank was used for Part 1. There was some evidence of poor dimensional accuracy of the provided blanks. In some instances parts were rusted, as candidates failed to use a suitable rust preventative spray.

Assembly, Finish & Function:

The vast majority of candidates were successful in assembling their test artefact. The quality of finish was generally very good. However, some candidates would have gained more marks had edges been draw-filed with a smooth file and fine grade emery cloth and burrs removed, particularly after final assembly. For some candidates the misalignment of drilled holes, especially between Part 1 and Part 3, affected the overall function of the mechanism. Some had difficulties with the smooth linear movement of Part 3 due to lack of clearance between, the cam, Part 5 and the 24mm slot in Part 3. Candidates should be made aware that '**function**' is a major objective in a precision engineering examination.

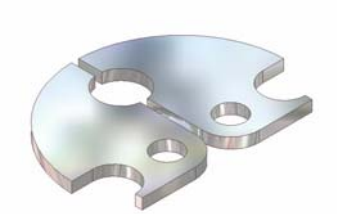
Part 1.

This part was the most straightforward of all the parts to produce. The accurate positioning of the drilled holes was critical to the smooth operation of the finished mechanism. Candidates lost marks generally due to one or a combination of the following factors:

- dimensional inaccuracy in the blank
- inaccurate location of the centreline holes or the threaded holes resulting in misalignment of fitted and moving parts

- 13 mm slot and 6mm radius on corners not filed or filed poorly.

Part 2 (x 2)



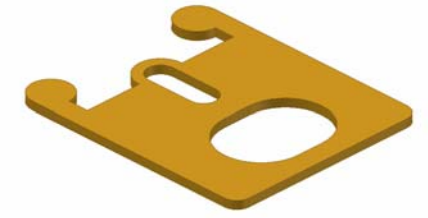
These parts were the most challenging components for candidates to complete.

Typically, marks were gained or lost due to candidate's skill level regarding some of the following elements:

- the accurate location of drilled holes Ø13, Ø12 and Ø8
- the accurate separation of the parts after drilling
- producing accurate profiles with high quality finish.

A small percentage of candidates separated the parts prior to drilling and valuable time was lost as a result of this action.

Part 3



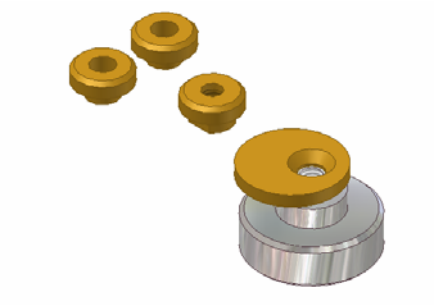
This part was made from brass with the more successful candidates scoring highly in dimensional accuracy and shape. Successful candidates produced a high quality polished finish on all edges of this profile.

Marks were lost due to:

- inaccurate shaping of the two Ø12 part discs which resulted in poor fitting, function and assembly
- poor finish and alignment of Ø 8 slot
- poor dimensional shape and finish of the 24mm slot resulting in incorrect movement and ineffective function of the assembly

- failure to file the 4mm radii.

Parts 4, 5, 6 and 7 (x 2)



These parts were prepared in advance of the examination and in general were of very good quality. The uniformity of parts which had been produced using CNC lathes in some centres, contrasted with parts which had been produced on manual lathes in other centres. Marks were lost due to:

- poor surface finish on lathe parts
- Part 4 threaded completely through the component
- 45º chamfers missing on one or both sides of Part 4
- filing the cam Part 5 resulted in some inaccurate shape profiles
- poor dimensional accuracy on the flats in Part 6.

4.4 Monitoring of Examination Centres

As with the written examination, the State Examination Commission (SEC) monitors the Practical Examination to ensure that the requirements of the Commission are complied with and the integrity of the examination is upheld. Examination and Assessment Managers (EAMs) of the SEC monitored a total of thirty-six examination centres for the Engineering Practical Examination in 2006.

The EAMs reported that the vast majority of centres were prepared as required and that the requirements of the SEC were being fulfilled. In only two centres were further enquiries necessary to check that all requirements were being observed and to ensure that the principle of inter-candidate equity was being upheld.

The following is a summary of the findings and observations made by EAMs following the 2006 monitoring process:

- most centres were properly laid out with special tools and equipment provided on dedicated benches
- all centres were run in an orderly manner
- there was no evidence of inappropriate use of unspecified machinery or equipment in the centres monitored
- Engineering teachers were present for the duration of the examination to:
    - issue tools and materials
    - prevent damage to equipment
    - ensure necessary special equipment is available to candidates
    - ensure the safety of the candidates
    - stamp the examination no. on candidates work
- all teachers were in full compliance with the directions, outlined in Circular S46/06, which states "The teacher is not permitted to give any direction or assistance to candidates in regard to the marking-out or execution of the test, but must ensure proper co-ordination of candidates' requirements in regard to specialised equipment".
- the examination papers were stored in a secure location under lock and key in all schools
- at the end of each examination the plastic envelopes containing the candidates test pieces were securely sealed by the superintendents and stored by the school authorities, as required
- all examination papers were collected between examination sessions and at the end of each examination and stored securely, as required.

The SEC acknowledges the co-operation of the Engineering teachers in assisting with the preparation the examination centres and in ensuring the smooth and safe running of the Practical Examination.

4.5 Conclusions

- Candidates were generally well prepared for the Practical Examination and the overall results reflect this preparation.

- The examination provided an opportunity for candidates to demonstrate different levels of skills in precision filing, drilling, fitting and accuracy within the given time.

- The examination effectively discriminated between candidates at different levels of achievement.

- The examination effectively assessed the ability of candidates to work on a wide range of materials and to use the machine tools prescribed in the syllabus, including the C.N.C. lathe.

- Most candidates completed the test in the allocated time and some excellent fully functional models were produced to a very high degree of accuracy and finish.

- In the vast majority of centres monitored by the SEC, the examination was conducted in an exemplary manner.

4.6 Recommendations to Teachers and Students

It is recommended that teachers:

- ensure that an adequate time provision is made for teaching and learning the skills associated with the Practical Examination

- remind students of the importance of completing the marking out of all pieces prior to processing and of the significant mark allocation for completing the marking out process

- advise students of the importance of accuracy and good finish of machined pieces and prepared blanks made prior to or during the examination and the significant mark allocation for same

- inform students that 'function' is a major objective in a precision engineering examination

- encourage students to place a special emphasis on the removal of burrs from parts and to use fibre jaws, or similar, to prevent vice jaws marks on examination pieces

- ensure, if selecting mild steel, that bright mild steel blank only is used, that these are cut on a power saw, not a guillotine, and that they are given a light coating of lubricant WD40 or similar spray

- advise students to use only the materials and equipment specified on the materials list for the Practical Examination

- ensure that examination numbers are clearly stamped or engraved in the position indicated on the drawing

  Note: Since a bar coded and labelled sealed plastic bag is provided for each candidate, it should not be necessary to also attach a tie on label. These hinder marking and incur a time loss, as they need to be removed.

It is recommended that students:

- read the instructions with the examination paper carefully and ensure that they have all the specified materials, tools and equipment

- process the marking out of all the pieces as one sequence of operations at the beginning and check the marking out for accuracy prior to commencing the processing

- be aware of the importance of accuracy and good finish of machined pieces and prepared blanks made prior to, or during, the examination and the significant mark allocation for same

- remove burrs from parts and always use fibre jaws, or similar, to prevent vice jaws marks on examination pieces

- use only the materials and equipment specified on the materials list for the Practical Examination

- on completing the assembly and functioning of the test artefact use any further time available for final finishing and polishing

- use the full, six hour, time allocation available for the examination.

5. Written Examination - Ordinary Level

5.1 Introduction

At Ordinary Level, the written paper is allocated 200 marks and represents 40% of the Engineering examination at this level. In 2006, 1332 candidates sat the written examination in Engineering at Ordinary Level. This represents 28% of the cohort who sat Leaving Certificate Engineering. A total of 71 (5.3%) of these candidates were female.

There was broad agreement among the team of examiners that the presentation and content of the examination material was well suited for this level and that the paper offered candidates opportunities to demonstrate their knowledge of the syllabus.

This part of the report should be read in conjunction with the examination papers and marking schemes, which are available on the State Examinations Commission website **www.examinations.ie**.

5.2 Performance of Candidates

The accompanying table shows the percentage of candidates achieving each grade in the Ordinary Level written examination for the years 2003 to 2006.

Year	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	1472	7.7	20.0	25.2	52.9	27.9	10.6	6.7	1.9	19.2
2004	1446	7.9	22.2	26.6	56.6	28.6	8.9	4.6	1.2	14.7
2005	1457	7.8	21.1	26.4	55.3	28.2	10.3	5.5	0.8	16.5
2006	1332	7.7	21.1	27.2	56.0	28.1	11.3	3.8	0.8	15.9

Table 14: Candidate Performance Ordinary Level written examination 2003 – 2006

The grades achieved in 2006 are very much in line with those of recent years. The A grade has remained at just below 8%, with 56% of candidates achieving grade C or higher. The percentage of candidates who failed to achieve grade D, or higher, has reduced slightly from 16.5% in 2005, to 15.9 % in 2006. However, the combined E/F/NG grade at 15.9% remains a cause of concern. An analysis of all of the 1332 scripts showed that 6.7% of candidates did not attempt the required four questions and some did not attempt the required number of parts within specific questions. Furthermore, for the

compulsory Question 1, a total of 12.2% of candidates scored less than 30 marks from the 65 available. Consequently many candidates failed to obtain sufficient marks, in the work attempted, to achieve the D grade. However, the overall outcome of the examination when the results all three examination components are included shows the combined E/F/N.G. reduced by half to 8.0%. This trend of candidates performing better in the practical components continues to prevail.

5.3 Analysis of Candidate Performance

The written examination consists of a total of seven questions from which the candidates are required to attempt four. Question 1, allocated 65 marks, is compulsory and candidates select any other three questions from the remaining six, each weighted equally at 45marks.

Examiners noted that the range of options within questions and the emphasis on the broad practical range of engineering equipment and process provided a well balanced and testing examination of candidates' knowledge of the Engineering syllabus.

The table below shows the frequency of attempts and average mark achieved per question, these and all following statistics are based on an analysis of all 1332 scripts.

Question No.	Attempts(%)	Rank Order	Average Mark	Topic
1	n/a	Compulsory	43	General knowledge
2	66.6	1	21	Metal production
3	58.0	2	21	Heat treatment
4	54.2	3	28	Fabrication
5	53.8	4	23	Plastics
6	50.5	5	26	Machining
7	34.7	6	27	Metrology

Table 15: Frequency of attempts and average mark for Ordinary Level questions

A further in-depth analysis of the total number of scripts showed that:

- 6.7% attempted less than the required four questions
- 28.2% attempted more than four questions
- 12.2% scored less than 30 marks in Q1
- 2.5% of candidates obtained full marks in Q1.

Examiners reported that the majority of candidates attempted the required number of parts in the compulsory Question 1. This is reflected in the very satisfactory average score achieved for this question. Even though Question 2, on metal production, continues to be the most popular question, the average mark is the lowest achieved at 21 marks. Attempt rates are relatively similar for Questions 3 to 6, with Question 4 eliciting the best results, averaging at 28 marks. Question 7, which includes a mathematical element, was the least popular question but candidates who attempted it generally scored well.

The following commentary is based on the observations of the team of examiners.

Question 1

Average mark: 43

Question 1, Section A

(a) Areas of work were answered well. Common answers were 'drilling', 'lathe', 'milling machine' and 'welding'.

(b) Part (iii) was most popular followed by part (ii). Candidates obtained full marks in most cases, 'P.C.B.', however, was rarely attempted.

(c) This part was attempted by most candidates but not always correct; 'copper', 'brass' or 'aluminium' were the most popular answers.

(d) This was a popular choice, and although answers varied, the candidate's knowledge was generally correct.

(e) This was not a popular choice and it was often confused with vacuum cleaning or 'blow moulding'. In some cases the 'vacuum forming' process was described well with no application given.

(f) Candidates gave a wide variety of answers to this part. Those who gave 'square thread' scored best.

(g) This was a popular choice and it was generally answered well. 'Mouse' and 'keyboard' were given by most candidates.

(h) This was not a popular choice; 'feeler gauge' featured when attempted.

Section B

(i) 'Plastic dip coating tank' was the most popular choice and descriptions varied considerably. The majority of candidate's answers within part (i) gave the function only. Problems arose in the operation of the tank. Many candidates stated that the plastic was heated while other candidates failed to make any reference to the use of heat in the process.
'Vee blocks and clamp' was the next popular choice but very few candidates associated its use with marking out. Only a very small number of candidates attempted 'Morse taper sleeve' and in most cases were incorrect.
Candidates' descriptions of operations were, generally, not detailed enough and insufficient use was made graphics to support answers.

(j) A popular question, with selections varying between 'Virus', 'Hard disk' and 'USB'. Explanations, however, were often limited to two or three words although greater detail was required for full marks. The term 'Hard disk' was not generally explained well and the term 'Computer network' was not clearly understood.

(k) This section was answered very well when attempted. The use of graphics proved very beneficial here and helped to secure full marks when used.

(l) 'Fuse' and 'Voltmeter' were the most popular choices followed by 'Pop rivet'. Explanations, again, consisted only of a few words and ranged from fair to good. There were few correct answers for 'Surface Plate'.

(m) This was not a popular question. 'Cam and follower' featured most, but candidate answers demonstrated a very low level of knowledge in this area.

Question 2

Average mark 21

(a) (i) Candidates offered the 'Blast Furnace' as the most popular answer.

(ii) Sketches and explanations of operation were generally poor. Many candidates described a different process to that which applied to the furnace named. It was evident that candidates were confused regarding the function of each furnace.

(b) This section was well answered and candidates secured full marks in most cases.

(c) The response to this question was generally poor. Many candidates only attempted one of the three parts. 'Galvanising' was the most popular and best answered. Some good attempts regarding the description of 'Tinplate' were evident, however, candidates responses to 'Bright mild steel' were less frequent and poor.

(d) A very small number of candidates attempted this section with very few correct answers.

Question 3

Average mark 21

(a) Answers to this part of the question were generally fair to good. Most candidates were capable of distinguishing between the resulting conditions. However, greater detail in explanations was required for full marks.

(b) Most candidates attempted to explain 'malleability' and 'elasticity'. However candidates generally only got one of the terms in this part of the question correct, suggesting a low level of knowledge in this area.

(c) Descriptions given here were generally very brief. Many candidates used the words given in the question i.e. "…case hardening is a hardened case…" and generally demonstrated a lack of understanding of the concepts involved. Very few candidates obtained full marks.

(d) Candidates demonstrated an excellent knowledge of the hazards involved and achieved full marks in all cases.

OR

(d) A very small number of candidates attempted this option. When attempted however, some candidates obtained full marks.

Question 4

Average mark 28

(a) This was a popular and well-answered question. Candidates demonstrated their knowledge of the 'oxy-acetylene flames' very well, but were not always correct in matching the name with the graphic.

(b) This part was popular and in the main well answered. Although there was a wide variation in answers, candidates generally demonstrated an acceptable level of knowledge.

(c) Responses to this part were also good. In general, candidates obtained full marks for (i) and (ii) while only the better candidates scored well in part (iii).

(d) This was well answered generally.

Question 5

Average mark 23

(a) Answers to this part were fair return, with only very brief descriptions given. 'Blow Moulding' featured most followed by 'Injection Moulding'. Candidates who used sketches to support answers scored the highest marks.

(b) Candidates displayed a good understanding of both 'Thermoplastic' and 'Thermosetting' plastic.

(c) This part was well answered and proved valuable, particularly for the weaker candidate.

(d) This was the weakest part, with few correct answers.

Question 6

Average mark 26

(a) A good understanding was demonstrated by the majority of candidates who attempted this part. Parts (ii), (iii) and (iv) were most popular. However, a small number of answer provided by candidates suggested that they may not have read the question correctly. In these instances the candidates only provided a description of the' lathe part', while the question required an application.

(b) Responses to this part were fair to good. The better candidate demonstrated a high level of knowledge here, particularly for part (ii).

(c) This was a very well answered part. Candidates demonstrated a good understanding of 'turning operations'. The use of sketches proved very beneficial here with the standard of sketches ranging from good to excellent.

OR

(c) This was not the most popular choice of the given option. The standard of answers was good but few were specific towards the use of a 'CNC lathe' as required.

Question 7

Average mark 27

(a) Most candidates scored high marks here. 'Clearance fit' and 'Interference fit' proved to be the most popular answers. Many candidates used sketches to good effect.

(b) Calculations were well answered with full marks in most cases.

(c) This was not a popular choice and there was a very poor response from those who did attempt this option. Very few candidates identified the 'micrometer' while no candidate was capable of naming the parts.

OR

(c) This was the most popular option and candidates generally scored well. The motor and battery symbols were the most successful parts.

5.4 Conclusions

- This examination effectively discriminated between candidates across the attainment range.

- Many candidates demonstrated a good knowledge of the syllabus and excellent levels of preparedness for the examination. 2.5% of candidates scored full marks in the compulsory Question 1 which included a range of options from the broad practical range of engineering equipment and processes.

- Some candidates had difficulties in producing coherently written answers and these difficulties were further compounded, according to examiners, by a reluctance or inability on the part of the candidate to use sketches / diagrams to support their solutions.

- 6.7% of candidates did not attempt the required four questions and some did not attempt the required number of parts within specific questions.

- It was evident from some scripts that a minority of candidates had not used the full time allocation available to complete the examination.

5.5 Recommendations to Teachers and Students

It is recommended that teachers:

- advise students to attempt all **four** questions and all required parts within each specific question
- encourage students to read the full examination paper at the start of the examination, before attempting any questions
- familiarise students with all requirements of the written examination
- encourage students to familiarise themselves with Marking Schemes and Sample Solutions to previous examination papers available on the SEC website (www.examinations.ie)
- encourage students to practice freehand sketching and line diagrams and advise them to use diagrams / sketches to support their answers as appropriate
- advise students to use the full allocation of time to sit the examination
- increase, where possible, the frequency of practical hands-on opportunities for using machinery in the classroom and continue to support learning by providing regular demonstrations in the workshop
- provide students with opportunities to practice describing practical activities in writing. The use of past examination papers is recommended in this regard.

It is recommended that students:

- read all the examination questions carefully at the beginning of the examination
- attempt the required **four** questions and thus maximise their chances of doing well in this component

- practice freehand sketching and drawing line diagrams, use this skill in the examination to convey information on technical detailing and thus gain the marks that are allocated for clear, well drawn, labelled diagrams

- be familiar with Marking Schemes and Sample Solutions to previous examination papers available on the SEC website (www.examinations.ie)

- use past papers and marking schemes to practice and become familiar with required techniques and terminology and to practice descriptions of workshop equipment and processes

- use the full allocation of time to sit the examination.

6. Written Examination - Higher Level

6.1 Introduction

At Higher Level, the written paper is allocated 300 marks which represents 50% of the Engineering examination at this level. In 2006, a total of 3429 candidates sat the written examination at Higher Level, this represents 72% of the total cohort who sat Leaving Certificate Engineering. A total of 175 (5.1%) of these candidates were female.

The examination paper allowed all candidates an opportunity to demonstrate their knowledge of the syllabus, and was generally perceived challenging but fair.

This part of the report should be read in conjunction with the examination paper and marking scheme, which are available on the State Examinations Commission website **www.examinations.ie**

5.2 Performance of Candidates

A total of 3429 candidates sat the written examination at Higher Level this year which was identical to the number of candidates who sat the written examination in 2005. The paper was similar in style and format to previous years.

The accompanying table shows the percentage of candidates achieving each grade in the Higher Level written examination for the years 2003 to 2006.

Year	Total	A	B	C	ABC	D	E	F	NG	EFNG
2003	3486	12.0	22.0	25.2	59.2	23.1	12.6	4.3	0.8	17.7
2004	3491	11.5	21.2	23.5	56.2	24.9	11.0	6.4	1.6	18.9
2005	3429	12.2	23.3	24.8	60.3	22.2	12.1	4.7	0.8	17.6
2006	3429	12.1	23.1	23.0	58.1	23.1	12.4	5.4	1.0	18.8

Table 16: Candidate performance Higher Level written examination 2003 – 2006

The grade profile of the results in 2006 is very much in line with those of recent years.

The majority of candidates fulfilled the requirement of answering Question 1 and four other questions from the remaining seven on the paper. A statistical comparison with 2004 shows a 0.6% increase in the candidates achieving grade A in 2006, but a marginal drop of 0.1% when compared to 2005. The percentage of candidates achieving grade C or higher in 2006 is 58.1%; this shows a drop of 2.2% in comparison with 2005 but an increase of 1.9% compared with the 2004 figures. The combined percentage of E/F/NG grades has increased by 1.2% compared with 2005, but is marginally lower than the 2004 figure.

5.3 Analysis of Candidate Performance

The written examination consists of a total of eight questions from which the candidates are required to attempt five. Question 1, with an allocation of 100 marks, is compulsory and candidates are required to attempt any other four questions from the remaining seven, each weighted equally at 50 marks.

The table below shows the frequency of attempts and average mark per question, based on an analysis of a random sample of 35.5% of the full cohort of 3429 scripts.

Question No.	Attempts (%)	Rank Order	Average Mark	Topic
1	n/a	Compulsory	68	General knowledge
2	78.4	2	32	Testing of metals
3	32.9	7	19	Ferrous metals
4	69.4	3	28	Non- ferrous metals
5	82.9	1	32	Welding
6	41.8	6	21	Plastics
7	47.0	5	27	Machining
8	57.7	4	33	General mechanisms

Table 17: Frequency of attempts and average mark for Higher Level questions

A further analysis of the sample of scripts showed that:

- 9.6% attempted less than the required four questions
- 22.8% attempted more than four questions
- 3.9% of candidates failed to attempt Q1. Section B, this years prescribed topic
- 1.8% of candidates obtained full marks in Q1.

Examiners reported that a large majority of candidates (90.4%) attempted at least the required five questions, with 22.8% attempting an extra question(s). The standard of answering was generally good, and was comparable to the standard of answering in recent years. A notable feature was the use of appropriately labelled diagrams by many candidates to support their answers, often where the use of diagrams was not specifically requested by the question itself.

Many candidates also demonstrated a high level of proficiency in the compilation and interpretation of graphs. Some candidates, however, experienced difficulty in extrapolating information from the graphs. In many centres candidates produced work which demonstrated high levels of knowledge, skills and preparation. However, it would appear that some centres concentrate on a reduced number of questions in order to cover some areas in greater detail. This has the effect of narrowing the students' experience of the broad Engineering course leading to vital components of the syllabus, such as machining, being omitted.

The special research topic, on 'pneumatic sequential control', proved quite challenging for a significant number of students who failed to grasp some of the basic concepts involved.

With approximately one in five candidates failing to achieve grade D or higher in the written examination, the underperformance of candidates is a cause for concern. Examiners have identified a number of factors that can be attributed to this:

- Examiners reported that some candidates were ill equipped to deal with the academic demands of Higher Level and would have been more suited to Ordinary level.
- a comprehensive analysis of a random sample of 35.5% of this years candidature revealed that 9.6% of candidates attempted less than the required number of questions
- Question 1, Section B, was not as well answered with 3.9% of candidates failing to attempt this years compulsory prescribed topic
- there was evidence of low levels of preparation by a small percentage of the cohort.

It is apparent from a comparison of the overall performance of candidates at Higher Level (P. 7) with the performance on the written examination that there is a disproportionate reliance by some candidates on the project and skills test components to enhance their overall grade. A more balanced performance across all three components would be more satisfactory conclusion.

The following commentary on candidate performance is based on the observations of the team of examiners.

Question 1

Average mark: 61.8

Question 1, Section A.

(a) This was a popular question and it was generally well answered with candidates showing a good knowledge of the safety signs shown.

(b) This was generally well answered

(c) The well prepared candidate displayed a good knowledge of this topic, which is not surprising given that it has appeared regularly in previous papers.

(d) This proved difficult particularly for the less able candidates who often, incorrectly, suggested 'casting' for (i) and 'injection moulding' for (iii)

(e) This was a popular choice and was generally well answered.

(f) This was well answered – often with the aid of an appropriate sketch.

(g) This part was not often attempted but when it was, 'Sikorsky' and 'Maiman' were the most popular choices.

(h) A surprising number of candidates confused part (i) the 'LDR' with a 'LED', or simply referred to it as a resistor. The 'capacitor' (ii), was a less popular choice and it was often mistaken as a battery or cell.

(i) This was a popular choice and it was generally well answered; 'electrical insulation' and 'resistance to corrosion' were the most common responses.

(j) This was reasonably well answered and usually illustrated with a sketch.

(k) This was well answered.

(l) This part was popular with all candidates. Appropriate explanations were generally given for the abbreviations.

(m) This was popular and reasonably well answered. Some candidates identified the 'gauge' as a 'tensile test' specimen.

Question 1, Section B (prescribed topic)

This year significant elements of the research topic proved quite challenging for the less able candidate. In comparison with previous years very few candidates scored the maximum marks in this section.

(n) A substantial number of candidates across the ability range outlined the general advantages of 'pneumatic systems' rather than focusing on 'pneumatic sequential control' as asked. Answers were similar to (q) (ii).

(o) (i) Candidates did reasonably well in naming the components.

(ii) In general, the functions were not very well explained.

(p) (i) Describing the 'cascade circuit' was generally the domain of the more able candidate.

(ii) The 'PLC' was well described. Less able candidates sometimes merely explained the abbreviation.

(iii) The 'FRL' was also well described although the less able candidates often merely explained the abbreviation.

(q) (i) This was a popular choice and it was generally well answered

(ii) This was well answered with a good range of benefits given.

(r) This part was popular and generally well explained. A small number of less able candidates misunderstood the question however and gave general safety precautions instead.

Question 2

Average mark: 32.2

Question 2 proved to be the second most popular of the non–compulsory questions selected by 78.4% of candidates and it was generally very well answered.

(a) (i) Most candidates were able to compare the indenters.

(ii) The elastic limit was well explained, often with the use of a graph or diagram.

(iii) Candidates generally were able to suggest two factors that affect 'fatigue failure'.

(b) The vast majority of candidates accurately plotted the 'load/extension' graph and achieved full marks for doing so. Some candidates had difficulty with determining the 'tensile strength' and calculating 'Young's Modulus' of elasticity.

(c) (i) This part was very well answered in general. 'Quality control' and economic factors were the most common reasons offered.

(ii) 'X- ray' and 'ultrasonic testing' were the most popular choices here. These were often accompanied by well drawn and labelled sketches.

Question 3

Average mark: 19.0

This question proved to be the least popular non-compulsory question and was attempted by only 32.9% of the candidates.

(a) Identification of the 'zones' marked A, B, C and D was generally poor. Candidates fared better at explaining the 'zones' selected.

(b) (i) This was a popular choice and it was generally well answered.

(ii) This part was not attempted very often. The quality of answers varied considerably.

(iii) This part was surprisingly unpopular, given that it included two reasonably common metals encountered by Engineering students.

(iv) This part was also popular and well answered.

(c) This was not a popular choice, however most of the candidates who attempted this section were able to name the instrument, state its function and outline the method of operation.

Question 4

Average mark: 27.9

This was the third most popular non-compulsory question and it was attempted by 69.4% of candidates.

(a)

(i) A good explanation of a 'solid solution alloy' was usually given.

(ii) There was some excellent answering to this part, with many candidates drawing a series of diagrams to represent 'dendritic growth'.

(iii) This part was very well answered and many candidates gave examples as part of the explanation.

(iv) This was less popular but a simplified diagram of a 'cooling curve' was regularly used to support the answer.

(b) The 'equilibrium diagram' was usually very well drawn. Typically the less able candidate only copied the diagram attempted part (iv) where they were required to indicate the 'eutectic point' on the diagram.

(i) Most candidates who attempted this part successfully identified the 'lines'.

(ii) This part was very well answered. Most candidates were able to explain satisfactorily what each 'line' represented. However, the 'solvus line' proved a challenge for the less able candidate.

(iii) Candidates attempted this section with varying degrees of success. Less able candidates often drew a line from the 250^0C point and dropped lines to the base line. Few continued to determine the 'composition of the phases'.

(c)

(i) This was a popular choice and it was generally well answered.

(ii) This was not as popular and it was sometimes mistaken as a 'vacancy' or 'point defect'.

(iii) This was a popular choice and it was well answered

Question 5

Average mark: 32.3

This was the most popular non-compulsory question and was attempted by 82.9% of candidates. It was also very well answered. Candidates had to be well prepared, as they were required to be familiar with 'MIG', 'MMA', 'TIG' and 'resistance welding' to answer the question completely.

(a)

(i) Most candidates correctly identified 'MIG welding'.

(ii) The method of operation was generally well described.

(iii) Candidates were not specific enough in suggesting applications and often just mentioned general welding applications.

(b)

(i) Some less able candidates confused the functions of the 'electrode coating' with the functions of the 'slag' produced.

(ii) Some candidates also confused the functions of the 'slag' produced with the functions of the 'electrode coating'.

(iii) This was very well answered particularly when explanations were accompanied by a well drawn diagram, as was often the case.

(iv) This was well answered and posed no problem for most candidates who suggested effective remedies for any safety hazards mentioned.

(c) Parts (i) and (ii) were equally well answered, with part (i) 'resistance spot welding' being the more popular choice. Excellent use of labelled diagrams accompanied by well structured answers typified candidate's attempts at this question.

OR

(c) This was not a popular option

(i) This part was well answered and candidates generally had no problem in listing a number of benefits.

(ii) This was probably the least well answered part on the paper.

Question 6

Average mark: 20.7

This question was the sixth most popular question on the paper; it was attempted by 41.8% of the candidates.

(a) Candidates who gave some thought to structuring their answer and presenting it in tabular form tended to benefit from that approach. Simple line diagrams representing the 'internal structures' were also commendable.

(b)

(i) This part was generally well answered but there were occasional references to filling cracks from the less well prepared candidate.

(ii) This was poorly answered.

(iii) This was a popular choice and usually well answered.

(iv) This part was poorly answered with less able candidates making incorrect associations related to foam.

(c)

(i) This was very well answered as most candidates were able to correctly identify the 'injection moulding' machine and describe its operation.

(ii) Appropriate components were regularly specified by candidates.
Most candidates were able to name the parts A, B, and C, but many were unable to name part D, the 'torpedo'.

Question 7

Average mark: 27.3

This was the least popular question and was attempted by 47% of the candidates.
Candidates who attempted it scored reasonably well.

(a)

(i) This was generally well answered

(ii) Most candidates were able to identify 'up-cut' and 'down-cut' milling but could not adequately differentiate between them.

(iii) This part was very well answered.

(b)

(i) This was very well answered and often accompanied by neatly drawn sketches.

(ii) 'Drill gauge' was generally well explained but the 'feeler gauge' caused problems for some.

(iii) This part was reasonably well answered. Diagrams were used to good effect by some candidates.

(iv) This was not a very popular part but again diagrams were used effectively by most candidates who attempted it.

(c)

(i) This was a popular part and was answered very well.

(ii) A significant number of candidates failed to mention hazards specific to machining mild steel.

OR

(c) This option was not a popular choice and was not attempted by a significant number of candidates.

(i) This was answered reasonably well.

(ii) Answers to this part were described by examiners as fair.

(iii) This part was reasonably well answered.

Question 8

Average mark: 33.0

This question was the fourth most popular question of the non-compulsory section with 57.7% of candidates selecting it.

(a) This question asked candidates to describe the operation and outline a suitable application for one of the two mechanisms shown. Both mechanisms were equally well identified and suitable applications were suggested by most candidates.

(b)

(i) This was the least popular part of this section.

(ii) The elimination of ‘slip’ was correctly identified by the majority of candidates.

(iii) This was generally well answered but some candidates made an incorrect association with the neutral gear in a car.

(iv) This part was well answered and usually accompanied by a well drawn diagram.

(v) This was a very popular part and was well answered. Good practical applications of the ‘rack’ and ‘pinion’ were suggested by most candidates.

(c) This section was poorly answered with only a minority making any reference to the ‘crank and slider’ mechanism.

OR

(c)

(i) This was a very well answered part. Most candidates had no problem identifying the circuit parts A, B, C and D.

(ii) The ‘circuit’ was well explained by the majority of candidates and relevant and appropriate applications were regularly suggested.

6.4 Conclusions

- The examination paper was effective in differentiating between candidates across the attainment range.

- Many candidates demonstrated a good knowledge of the syllabus and excellent levels of preparedness for the examination.

- Some of the more successful candidates gave structure to their answering by, where appropriate, tabulating their answers, using bullet points to highlight and

give emphasis, presenting neat and accurate graphs and using sketches and diagrams to illustrate their answers where appropriate.

- 90.4% attempted at least the required five questions, with 22.8% attempting an extra question(s).

- There was some evidence that candidates did not use the full time allocation of three hours to complete the examination.

- A significant percentage of candidates failed to prepare adequately for Question 1, Section A which is a compulsory question where ten parts must be attempted in order to achieve full marks. This year only 1.8% of candidates scored the full 100 marks in Question 1.

- The special research topic, on pneumatic sequential control, proved quite challenging for a significant number of candidates who failed to grasp some of the basic concepts involved.

- Many of these candidates found the Higher Level paper too challenging and would have been better advised to attempt the Ordinary Level paper.

5.5 Recommendations to Teachers and Students

It is recommended that teachers:

- advise students to attempt Question 1 and four other questions and all required parts within each specific question

- encourage students to read the full examination at the start of the examination, taking note of key words, before selecting any questions

- provide formal instruction for students in the requirements of the examination and in the techniques necessary for the effective answering of the questions posed

- encourage students to familiarise themselves with Marking Schemes and Sample Solutions to previous examination papers available on the SEC website (www.examinations.ie)

- encourage students to practice freehand sketching and line diagrams and advise them to use diagrams/sketches to support their answers as appropriate

- advise students to use the full allocation of time to sit the examination

- advise and guide students in relation to their choice of level

- ensure that students are familiar with the terminology used in past exam papers. They should know the significance of common question cues such as *identify, outline, explain, distinguish, differentiate, compare, describe,* etc.

- advise students of the importance of being able to extrapolate information from graphs and associated formulae and calculations

- encourage students to allocate time towards proper research and preparation for Q.1 Section B during the two years leading up to the examination as it carries a significant amount of marks.

It is recommended that students:

- read all the examination questions carefully at the beginning of the examination, and take note of key words, before selecting any questions

- attempt the required **five** questions and thus maximise their chances of doing well in this component

- use sample solutions to practice and become familiar with the terminology used in past exam papers and understand the significance of common question cues such as *identify, outline, explain, distinguish, differentiate, compare, describe,* etc.

- practice freehand sketching and drawing line diagrams and use this skill in the examination to convey information on technical detailing and thus gain the marks that are allocated for clear, well-drawn, labelled diagrams

- familiarise themselves with the Marking Schemes and Sample Solutions to previous examination papers. These are available on the SEC website (www.examinations.ie)

- use the full allocation of time to sit the examination

- be able to extrapolate information from graphs and associated formulae and calculations

- give adequate time to research and preparation for Q1 Section B during the two years leading up to the examination as it carries a significant amount of marks.