Coimisiún na Scrúduithe Stáit

State Examinations Commission

LEAVING CERTIFICATE EXAMINATION 2011

ENGINEERING (MATERIALS & TECHNOLOGY)

ORDINARY LEVEL CHIEF EXAMINER'S REPORT

HIGHER LEVEL CHIEF EXAMINER'S REPORT

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1. General Introduction

1.1 The Syllabus

The present Leaving Certificate Engineering syllabus was first examined in 1985. This syllabus is examined at two levels – Ordinary Level and Higher Level.

1.2 The Examination

At Ordinary Level the examination comprises the following three components:
(i) Engineering – TechnologyProject: Manufacture
(ii) Practical Skills Examination
(iii) Written examination.

Ordinary Level candidates are required to attempt all three components.

The Higher Level examination also comprises three components, as follows:
(i) Engineering – Technology Project: Design
(ii) Practical Skills Examination
(iii) Written examination.

Higher Level candidates are required to attempt all three components.

1.2.1The Technology Project

Each candidate, at both Ordinary Level and Higher Level, is required to submit a model and a design folio, which they have completed, based on the Engineering - TechnologyProject examination paper. The project examination paper is issued to schools by the State Examinations Commission (SEC) in mid-October of year two of the Leaving Certificate programme. Candidates are required to complete the project by March of the following year.

The examination paper at Higher Level includes a design brief, with specific design criteria and instructions for making the model and compiling the folio.

At Ordinary Level, the examination paper includes a project brief consisting of a drawing of the model to be manufactured, and instructions for making the model and compiling the folio. However, candidates can manufacture the model based on an alternative design, provided the criteria outlined in the examination paper are adhered to.

Each year, the SEC issues instructions to teachers and candidates regarding the requirements for the submission of valid coursework. The requirements for the acceptance of practical coursework for assessment are outlined in Circulars S68/04 and S69/04. Copies of these circulars are available on the SEC website www.examinations.ie.

All project work submitted for examination must be the candidate's own individual work, and must be carried out under the supervision of the class teacher. At Higher Level, the candidate's own individual work is intended to include the intellectual activity of design, along with the practical activities of making the model and compiling a design folio. At Ordinary Level, the candidate's own individual work is intended to include practical activities of making the model from the given drawing or according to an 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 examined by a team of external examiners, appointed, trained and monitored by the SEC.

1.2.2 The Practical Skills Examination

The Practical Skills Examination is a six-hour test which takes place in the school, under examination conditions, in early May. This component is available at Common Level only. Lists of specific equipment and materials required for the examination are sent by the SEC to the schools in October, along with drawings and specifications for parts which each candidate is required to prepare prior to the examination.

The examination paper for the Practical Skills Examination requires candidates to interpret a drawing, and to mark out, process, finish, and assemble the test piece. On completion of this examination, all test pieces are sent to the SEC, in Athlone. The test pieces are examined in June by a team of external examiners, appointed, trained and monitored by the SEC.

1.2.3 The Written Examination

The written examination, at both Ordinary Level and Higher Level, takes place in June.

Ordinary Level

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

Higher Level

The written examination at Higher Level is of 3 hours duration. The examination consists of a total of eight questions, of which candidates are required to answer Question 1, Sections A and B, and any four other questions from the remaining seven.

1.2.4 Mark Allocations and Weightings

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

Engineering	
Higher Level	**Marks**
Technology Project: Design	150
Practical Skills Examination	150
Written (Materials and Technology)	300
Total	600
Ordinary Level	**Marks**
Technology Project: Manufacture	150
Practical Skills Examination	150
Written (Materials and Technology)	200
Total	500

Table 1: Leaving Certificate Engineering (Higher Level and Ordinary Level)- examination format and mark allocations

Ordinary Level

At Ordinary Level, the written examination equates to 40% of the Leaving Certificate Engineering examination, while the project and the practical skills examination each represents 30%. The following chart shows the mark weightings for each component:

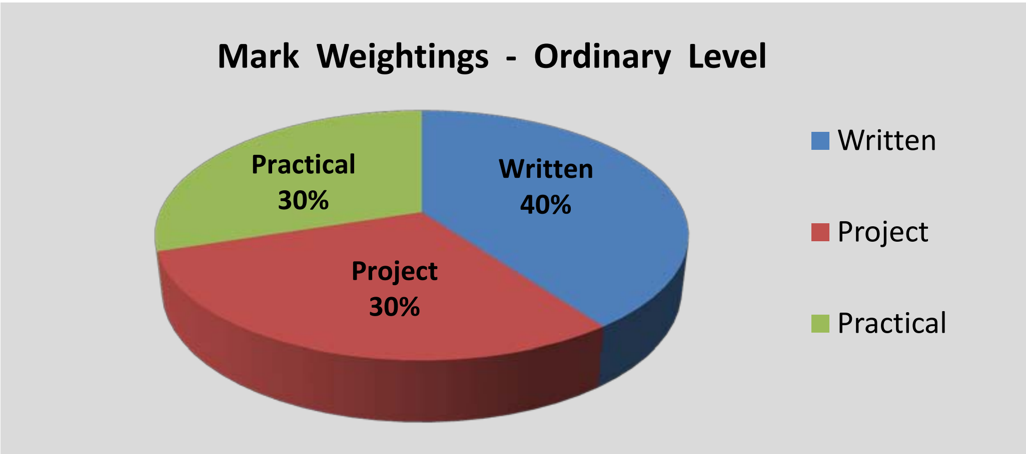


Table 2: Leaving Certificate Engineering – Mark Weightings in %– Ordinary Level

Higher Level

At Higher Level, the written examination equates to 50% of the Leaving Certificate Engineering examination, while the project and the practical skills examination each represents 25%. The following chart shows the mark weightings for each component:

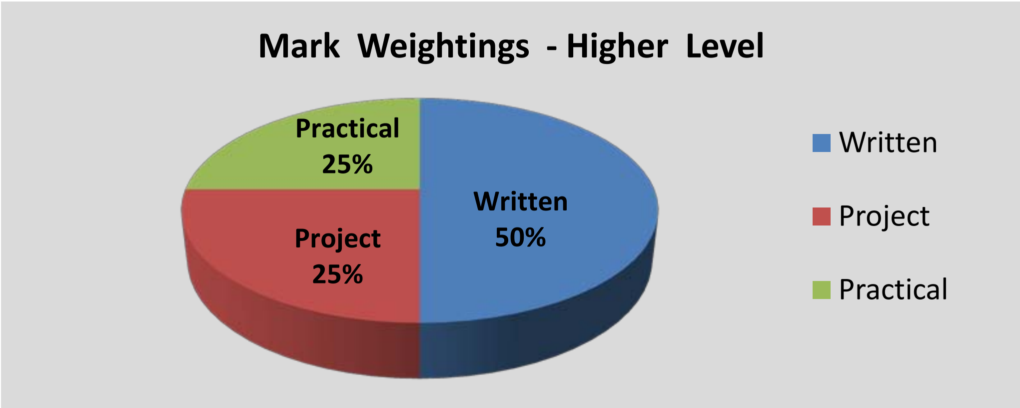


Table 3: Leaving Certificate Engineering – Mark Weightings in %– Higher Level

1.3 Candidature

The number and percentage of candidates taking Leaving Certificate Engineering from the full Leaving Certificate cohort for the years 2009 – 2011, is shown in Table 4 below.

Year	Leaving Certificate candidature	Engineering	% of cohort
2009	54,197	4,909	9.1%
2010	54,480	5,026	9.2%
2011	54,344	5,063	9.3%

Table 4: Leaving Certificate Engineering – candidature 2009-2011

Table 5 below shows the number of candidates taking Engineering at Higher Level and Ordinary Level from 2009 to 2011. The number of candidates taking Higher Level has increased by 4.8% from 2009 to 2011, while there has been a corresponding decrease in the Ordinary Level cohort.

Year	Total	Ordinary Level		Higher Level	
		Candidature	%	Candidature	%
2009	4,909	1306	26.6%	3,603	73.4%
2010	5,026	1166	23.2%	3,860	76.8%
2011	5,063	1103	21.8%	3,960	78.2%

Table 5: Leaving Certificate Engineering (Ordinary and Higher Levels) – candidature 2009-2011

1.4 Participation by gender

The male candidature continues to significantly outweigh the female candidature in the subject. For the past three years, females have represented approximately 5% of the subject cohort. The actual number of female candidates taking the subject ranged from 258 in 2009 to 217 in 2011.

Table 6 outlines the gender participation at each level from 2008 to 2010.

YEAR	Total cohort		Ordinary Level		Higher Level	
	Male	Female	Male	Female	Male	Female
2009	94.7	5.3	94.1	5.9	95.0	5.0
2010	95.6	4.4	94.1	5.9	96.1	3.9
2011	95.6	4.4	93.0	7.0	96.3	3.7

Table 6: Leaving Certificate Engineering (Higher Level and Ordinary Level) – participation by gender 2009-2011. Figures given are percentage

2. Performance of Candidates

2.1 Ordinary Level

The overall performance of candidates at Ordinary Level over the past three years is shown in Table 7 below. This represents the grades achieved when marks for each of the three examination components are combined.

Leaving Certificate Engineering - Ordinary Level										
	Total	**A**	**B**	**C**	***ABC***	**D**	**E**	**F**	**NG**	***EFNG***
2009	**1,306**	3.0	23.2	38.5	***64.7***	27.2	6.4	1.8	0.0	***8.2***
2010	**1,166**	2.0	26.0	39.7	***67.7***	25.1	5.5	1.5	0.1	***7.1***
2011	**1,103**	1.9	22.2	40.1	***64.2***	27.2	6.9	1.5	0.1	***8.5***

Table 7: Leaving Certificate Engineering (Ordinary Level) – grade outcomes 2009-2011

The grade distribution is broadly similar over the three years at Ordinary Level. However, 64.2% of candidates achieved grade C or higher in 2011. This represents a decrease of 3.5% when compared to the combined A, B and C grades for 2010. In 2011, there was a10.1% reduction in the ABC grades from 2010 for the Ordinary Level project.

The Technology Project: Manufacture, as previously outlined, equates to 30% of the available mark allocation for the examination at Ordinary Level. Examiners reported that some candidates who opted for the Higher Level project would have been better suited to Ordinary Level. Examiners also noted that the shift in cohort may have impacted on the examination outcomes and contributed to the reduction in the overall ABC grades from 2010.

The following table shows the percentage and distribution of grades achieved by male and female candidates at Ordinary Level in 2011.

Engineering - Ordinary Level 2011										
	Total	**A**	**B**	**C**	***ABC***	**D**	**E**	**F**	**NG**	***EFNG***
2011	**1,103**	1.9	22.2	40.1	***64.2***	27.2	6.9	1.5	0.1	***8.5***
Female	**77**	1.3	7.8	35.1	***44.2***	41.6	11.7	2.6	0.0	***14.3***
Male	**1,026**	2.0	23.2	40.5	***65.7***	26.3	6.5	1.5	0.1	***8.1***

Table 8: Leaving Certificate Engineering (Ordinary Level) 2011 – grade outcomes by gender

An analysis of figures shows 7.0 % of the cohort at this level was female and,while males and females performed similarly at the A grade, male candidates out performed their female counterparts at the combined ABC grades.

2.2 HigherLevel

The overall performance for candidates at Higher Level from 2009 to 2011 is shown in Table 9 below. This represents the grades achieved when marks for each of the three examination components are combined.

Leaving Certificate Engineering - Higher Level										
	Total	**A**	**B**	**C**	***ABC***	**D**	**E**	**F**	**NG**	***EFNG***
2009	**3,603**	8.7	32.1	36.3	***77.1***	19.4	3.1	0.4	0.1	***3.6***
2010	**3,860**	9.3	32.3	34.7	***76.3***	20.1	3.0	0.5	0.1	***3.6***
2011	**3,960**	11.2	31.6	33.7	***76.5***	19.4	3.3	0.7	0.0	***4.0***

Table 9: Leaving Certificate Engineering (Higher Level) – grade outcomes 2009-2011

The outcomes at Higher Level are broadly consistent with those of previous years. Examiners noted that the standard in the three components examined at this level was particularly high in some cases. This is reflected in the increase in the number of candidates achieving an A grade at this level. In the written examination, examiners noted an increase in the quality of answering, especially in Question 1, Sections A and Section B - the prescribed topic, where candidates demonstrated an excellent understanding of incineration technology.

The combined EFNG grade remains low. However, there is a slight increase in the EFNG grade from 2009 and 2010 which may be attributed to the shift in cohort from Ordinary Level to Higher Level, referred to earlier. Examiners noted that many of these candidates would have been better suited to Ordinary Level, as there was evidence that some were less prepared for the higher order skills required to deal with the more difficult concepts encountered at Higher Level.

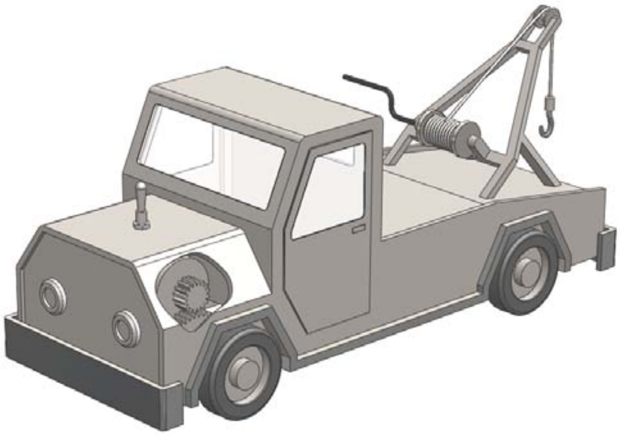
The following table shows the percentage and distribution of grades achieved by male and female candidates at HigherLevel in 2011.

Engineering - Higher Level 2011										
	Total	**A**	**B**	**C**	***ABC***	**D**	**E**	**F**	**NG**	***EFNG***
2011	**3,960**	11.2	31.6	33.7	***76.5***	19.4	3.3	0.7	0.0	***4.0***
Female	**148**	12.2	25.1	28.3	***65.6***	29.4	4.1	0.7	0.0	***4.8***
Male	**3,812**	11.2	32.0	33.8	***77.0***	19.0	3.3	0.7	0.0	***4.0***

Table 10: Leaving Certificate Engineering (Higher Level) 2011– grade outcomes by gender

An analysis of figures shows that 4.4% of the cohort at this level was female and, while females slightly outperformed their male counterparts at the A grade, the combined ABC grades show males performed very well.

2. Technology Project: Manufacture- Ordinary Level



Model Recovery Truck

3.1 Introduction

The Technology Project: Manufacture, is designed to assess a range of skills and competencies as specified in the syllabus. The skills are developed by engagement with the syllabus content through a practical-based learning process. As previously noted, project work accounts for 30% of the total marks available at Ordinary Level, where candidates are required to submit a model and a design folio.

In 2011, a total of 954 candidates submitted the Technology Project: Manufacture, at Ordinary Level. In the general specifications, outlined in the examination paper, candidates were required to make a Model Recovery Truck, according to the example shown in the diagram above or according to an alternative design.

Project briefs 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 candidates' solutions to the given brief. Examiners noted the display and diversity of design skills, with some excellent alternative designs often represented in the folio. Examiners also reported excellent demonstrations of practical skills, with high levels of accuracy and finish in project models. These were manufactured to high standards, using a wide variety of engineering processes.

Examiners also reported examples where both the skill levels and quality of work submitted were less consistent. The standard of presentation of the folio was reported as excellent in many cases. However,for many candidates there is still cause for concern in relation to the level of effort afforded both the finish and presentation of the model and the folio.

Projects were marked by the application of the marking scheme, which was issued as part of the project brief in October 2010. The marking process commenced in schools on Tuesday 7th June 2011, and was completed on Friday 17th June 2011. As part of the quality assurance processes, an Advising Examiner monitored the work of each examiner during the marking process, in order to ensure accuracy and consistency in the marking process.

Examiners noted that, in most centres, teachers and candidates had put considerable effort into the layout and presentation of the manufactured models and folios. Such an approach values the effort of the candidates and has the added benefit of offering a showcase within the school for the creativity and skills of the candidates. The SEC acknowledges the assistance of the Engineering teachers and the school authorities in the preparation and layout of centres for marking the projects.

3.2 Performance of Candidates at Ordinary Level

A summary of the results achieved by candidates in this component at Ordinary Level for the years 2009 to 2011 is presented in Table 11 below.

Year	Total	A	B	C	*ABC*	D	E	F	NG	*EFNG*
2009	**1111**	22.3	29.9	24.2	***76.4***	10.4	8.4	4.2	0.5	***13.1***
2010	**981**	25.1	30.9	25.5	***81.4***	8.2	5.1	3.9	1.4	***10.4***
2011	**954**	20.3	29.9	21.1	***71.3***	15.9	8.5	3.7	0.6	***12.8***

Table 11: Leaving Certificate Engineering (Ordinary Level) Project - grade outcomes 2009-2011

Note: *The grades awarded to candidates in Leaving Certificate Engineering are computed from the combined results of the relevant components completed by candidates*.

The number of candidates attempting the Ordinary Level project has declined in recent years. There was a 10.1% reduction in the ABC grades from 2010 for the Ordinary Level project. Specifically, the number of candidates achieving an Agrade was down by 4.8% on 2010, with the number achieving C grade also showing a decrease of 4.4%. There was little change in the number achieving B grade in comparison with the previous two years.

An analysis of all projects marked at this level showed that a total of 268 candidates (28%) failed to submit a folio.This is reflected in the D and EFNG grades where15.9% of candidates achieved a D grade in 2011 compared to 8.2% in 2010, and there was a 2.4% increase in the combined EFNG grades from 2010.

3.3 Analysis of Candidate Performance at Ordinary Level.

The following commentary, which is based on the reports of the examiners, is intended to aid teachers and candidates preparing for future examinations. This section should be read in conjunction with the relevant examination papers and marking schemes, which are available on **www.examinations.ie.**

Examiners noted that candidates showed a high degree of engagement with this project, with many opting to design and manufacture their own alternative design. This alternative design gave scope to candidates to exercise their imaginative skills, and some excellent work was presented. Successful candidates availed of the opportunity to demonstrate their bench and manufacturing skills to excellent effect, with many producing well thought out, well-assembled and functioning models, with high levels of accuracy and finish inherent. Some candidates presented work that was poorly designed and, in some instances,poorly manufactured.

The overall decrease in the percentage of the cohort submitting project work at Ordinary Level is reflected in the decline in the overall performance of candidates at this level in 2011 compared to recent years. Examiners expressed the view that some candidates, more suited to Ordinary Level, opted for the Higher Level project. It was also noted that these candidates would, perhaps, have scored better at Ordinary Level, given that the emphasis at Ordinary Level is on a manufacture-orientated project brief. Another factor which impacted on the overall performance was the significant percentage of candidates who failed to submit a folio. Clear directions to candidates regarding the compilation of the folio and the manufacture of the model are given in the examination paper.

The following commentary and analysis of the individual elements of the project is based on the reports of the examiners. While frequent errors are identified in the analysis, this is intended to aid teachers and to further improve on overall candidate performance in this examination.

The Folio - Planning and Organisation

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 examination paper, under the heading ‘Planning and Organisation’ for the compilation of the folio. These are further reinforced in the marking scheme under the heading ‘Marking Criteria – Folio’.

Some candidates followed the format of the Higher Level folio. Candidates using this format did not satisfy the project brief and consequently some of the work presented could not be rewarded. In some cases, candidates managed their time poorly and thus spent an excessive amount of time on manufacturing the model, leaving insufficient time for the folio. This mismanagement of time can further impinge on the time available for studying the theory component of the examination. Project management needs to be addressed prior to and during the design process.

Candidates who were successful had carefully read the Project Brief and the marking scheme in the examination paper and followed the directions therein. They produced a concise design folio detailing all aspects of their work, which included the following sections:

(a) Planning details required before undertaking the task or alternative design details;

(b) Parts list and working drawings;

(c) Organisational plan, indicating the manufacturing processes, materials and finishing treatments to be used;

(d) Testing and evaluation of the finished model including special instructions, if necessary, regarding the testing of the model by an examiner.

Planning/ Alternative Design:

In general, candidates developed and manufactured their own alternative design. If using an alternative design or any variation on the given drawing, candidates are engaging in a design process and must clearly demonstrate and provide details regarding any alterations/alternative designs. Examiners noted that ‘planning’frequently consisted of some internet downloads of recovery trucks. Some candidates produced a sketch or drawing of their final solution with no evidence as to how this final solution was arrived at. Good planning and research should help with the formation of ideas which lead to a final solution. Good planning and research may include the following:

- using internet research or books to obtain ideas
- sketching these ideas towards forming a final solution or elements of a final solution
- visual inspection of existing models for ideas and proper dimensional proportions
- talking to people involved in manufacturing, use or sales of existing models
- using a variety of modelling techniques, including mock-ups/models of ideas/final solution and using CAD to model potential solutions.

All evidence of this planning/research should be communicated by inclusion in the folio.

Parts List and Working Drawings:

Examiners noted that the standard of working drawings varied from excellent to weak. Some candidates put considerable effort into their working drawings, with some excellent use of CAD in evidence. Many of these candidates used *Solid Works* to produce their drawings. In some instances, these were accompanied by accurate and detailed parts lists. However, many candidates produced drawings which were inaccurate, incomplete, poorly dimensioned and lacking in clarity. Some candidates failed to produce parts lists.

Work Plan/ Manufacturing:

Candidates' responses to this section ranged from very good to very poor. Some included details and sketches/photos of the manufacturing processes and the time-scale involved. Some candidates require guidance in techniques for compiling a work plan for the manufacture of the model before project work commences. This aspect of Project Management, if addressed, will enhance the quality of the finished model. In the work plan, candidates must identify the processes and procedures undertaken to manufacture the model.

Materials and Finishes:

Examiners noted that this section on 'finishing treatments'was the most neglected section of the folio. Many candidates described the finishing techniques which were applied to each of the materials used in the manufactured model. However, a significant number of candidates failed to mention finishing techniques or materials. Emphasis should be placed on these, as the benefits will result in marks awarded for this section of the folio. This is particularly the case if knowledge is applied in the function as well as in the general and detailed appearance of the model.

Testing and Evaluation:

Examiners noted that many candidates produced a good evaluation, but there was less evidence of proper testing. Candidates, in many cases, did not carry out tests in accordance with the brief. It was also noted that, for some candidates, the evaluation was in the form of an overall conclusion, referring to time management difficulties and poor planning. Evaluation should be ongoing and is dependent on testing. Candidates should examine the results of various tests and come to a conclusion to see where the manufactured model is successful and in which areas there is room for improvement. These should be communicated in this section of the folio.

Presentation of Folio:

Marks are allocated to the presentation of the folio. Many candidates were rewarded for the time and energy devoted to the development of the folio. However, some candidates lost marks due to poor structure or lack of attention to detail in their folios.

Folios not presented:

An analysis of all projects marked at this level indicated that a total of 268 candidates (28%) failed to submit a folio. At Ordinary Level, candidates must, at least, before commencing the manufacture of the final solution, complete the following folio sections: planning details, alternative design details, parts list and working drawings. Some candidates, especially if using an alternative design or any variation on the given drawing, appear to have had difficulties engaging with the design process, understanding what is expected at each stage of the design process, and the concept of project management. It would be beneficial to these candidates if specific time were spent, prior to the issue of the design brief, guiding candidates through the design process as part of a practical course work assignment. Some candidates should pay more attention to the directions and the marking scheme, which are included in the examination paper.

The Model - Project Manufacture

The more successful candidates had carefully read the Project Manufacture section of the project brief and the marking criteria for the model in the examination paper, and followed the directions therein. Successful final solutions had to include the following directions:

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

(i) An electrical drive for the model operated by means of an ON/OFF switch;

(ii) One decorative feature to enhance the presentation of the model.

(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 250 mm.

(e) Electric power should not exceed 9 volts.

'Make a Model Recovery Truck according to the example shown or according to an alternative design':

Some candidates developed and manufactured their own alternative design. Some other candidates attempted to base their designs closely on the given drawing but incorporated additional designs or alterations to specific parts in their manufactured solution. Examiners noted that there were some excellent models produced. Many of these involved innovative alternative designs displaying a variety of lifting mechanisms and recovery devices, such as sliding tables, and hinged and sliding ramps. The more successful solutions resulted from good finish, proportion, and stability.

Less successful examples exhibited limited skill level and poor finish. There were also difficulties in specific cases with proportion and with lack of attention to safety. Examiners reported many cases where the model did not have a functioning lifting/recovery device on the model.

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

An electrical drive for the model operated by means of an ON/OFF switch:

Many candidates elected to provide electrical drive for the front axle. The predominant electrical drives used were motor and pulley, gearbox, and worm gear systems. Most models had a basic toggle switch incorporated into the circuit. Some candidates failed 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 leaving the supplied circuit components lying next to the model. This basic electronic circuit is very similar to those used in the Junior Certificate Metalwork projects and it is important that candidates be familiar with these prior to beginning the Leaving Certificate Project.

One decorative feature to enhance the presentation of the model:

Some candidates made maximum use of the opportunity to tastefully decorate and contribute to the appearance of the models. Some of the decorative features used to enhance the model included spray painted designs using stencils, hammered or mottled finish, opening doors, spray painted finishes, and tinted windscreens. This aspect seemed to be within the scope of most candidates.

Constraints -clearly visible, not exceeding 250 mm and not exceeding 9 volts:

All of the specified constraints were adhered to, in the vast majority of completed models.

Other Observations on the Model

Materials used:
The recovery truck bodies were generally made from sheet aluminium or acrylic. Many candidates marked the development of the truck on aluminium sheet and then cut out the shape and folded it to the required truck shape. Acrylic was used to good effect in some cases. However, there were instances where candidates used excessive adhesives to join acrylic.

The winch or other recovery devices gave candidates an opportunity to work with a variety of materials readily available in the Engineering room. Wheels were usually either bought in or manufactured from nylon. In general, the materials used were suitable and satisfied the brief.

Assembly techniques:
Candidates demonstrated a variety of assembly techniques with varying degrees of success. Candidates predominantly used pop rivets, machine screws and/or adhesives. Examiners noted that some examples of poor assembly included:

- Wheel nuts not secured properly
- Incomplete electronic circuit
- Gears not meshing correctly.

One area of concern was the alignment and stability of the drive motor or gearbox units.

Manufacturing skills:

Skill levels varied from excellent to poor. Examiners noted that successful assembly of the project was dependent on the accuracy of marking out and the quality of manufacture of each component.

Many candidates used shaping, bending and joining of sheet metal and acrylic in the construction of the cab, boom/winch, recovery table and windscreen. The use of developments featured in many centres to good effect. Some candidates demonstrated excellent machining techniques in manufacturing wheels. These were, generally,from nylon/aluminium, and from wood in some centres. Vacuum forming was not widely used in the manufacture of this model.

Finish and Presentation:

Examiners noted that, in a number of instances, insufficient attention was given to this aspect of the manufacturing process. The importance of finish has been highlighted in the examination paper and in previous Chief Examiner's Reports. High quality finishes on components may significantly improve efficiency in movement, the potential for accurate assembly, the aesthetic appearance of the component and the overall presentation of the complete model. There is also a significant allocation of marks awarded to finish and presentation of the model. In some instances, examiners reported extremely high standards of finish. It was noted that some candidates used spray painting to good effect. Examiners, in reporting a broad spectrum of finish quality, noted that some candidates had produced high quality finishes where components were made from acrylic, but that this standard was not replicated on the components made from metal.

The overall standard of finishing was rather inconsistent and marks were lost by candidates paying insufficient attention to finish or fine detail. Examiners noted that this year's project showed no appreciable improvement in the quality of finish applied when compared with previous years. Frequently there was insufficient attention paid to de-burring, draw-filing and polishing the external edges of the components.Examiners also reported on instances of poorly drilled and unfinished holes, excessive use of adhesive, protrusion of long machine screws, materials left in their raw state, and electronic circuits left incomplete, unfinished or loosely assembled.

3.4 Conclusions

- Examiners commented on the display and diversity of design skills, and on some excellent alternative designs.

- There were many excellent demonstrations of practical skills, with high levels of accuracy and finish in project models. These were manufactured to very high standards, using a wide variety of engineering processes.

- In general, candidates developed and manufactured their own alternative design. However, many candidates failed to clearly demonstrate and provide details regarding any alterations/alternative designs.

- The quality of the folios submitted was, in some instances,very high, 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.

- Some candidates incorrectly followed the Higher Level folio format and others managed their time poorly. These spent an excessive amount of time on manufacturing the model, leaving the folio as a rushed and incomplete 'add on'. This mismanagement can further impinge on the time available for studying the written component of the examination.

- Some candidates were less successful in the folio. This as due, in the main, to lack of evidence of planning or developing the alternative design. There were folios where working drawings were often without dimensions and some folios contained no evidence of finishing techniques. This impacted negatively on both the folio and the model.

- A significant proportion of candidates failed to submit a folio. This is a prescribed element of the project.

- Examiners noted that some candidates demonstrated poor practical skills and submitted projects which were manufactured to poor standards.

- Some candidates failed to pay adequate attention to the finishing of each individual component, and to the overall presentation of the model.

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

3.5 Recommendations to Teachers and Students

It is recommended that teachers:

- ensure that all students have a full copy of the examination paper for the Engineering – Technology Project: Manufacture, and that they are familiar with and fully understand the General Instructions to Candidates, and the Project Brief

- continue to validate only coursework completed in school under their direct supervision and according to the instructions issued by the State Examinations Commission. This ensures the integrity of the coursework being assessed and upholds the principle of inter-candidate equity

- guide students in planning their work in advance, and in devising a basic project management log. This assists them in setting targets and in making optimal use of the time spent on project work

- emphasise to students the importance of completing the folio under the headings outlined in the Project Brief section of the examination paper

- guide students towards providing the necessary planning details when developing an alternative design

- guide students towards producing working drawings which are accurate and well dimensioned

- emphasise to students the importance of achieving good finish on each component manufactured and on the completed model, and the significant mark allocation for same

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

- emphasise the importance of keeping design simple and effective, and also that it is manageable to complete within the time constraints of the Ordinary Level examination

- familiarise students with the requirements of past examination papers in the Technology Project: Manufacture, and provide them with regular opportunities to apply the manufacturing process and finishing techniques which they have learned through coursework over the years of study leading to the examination

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

- ensure that all students have completed and signed the necessary documentation relating to the coursework before the end of the school year

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

It is recommended that students:

- familiarise themselves with the *General Instructions to Candidates*, the *Project Brief* ,and the *Marking Criteria* which are issued by the SEC with the Engineering – Technology Project: Manufacture, examination paper, and follow these in the execution of their project work

- manage their time carefully so that they do not spend a disproportionate amount of time on project work at the expense of the written component

- when developing an alternative design, include all evidence of this planning/research in the folio

- produce working drawings which are accurate and well dimensioned

- identify in the work plan, the processes and procedures undertaken to manufacture the model

- pay particular attention to the finishing of the individual components that make up the model and folio, as well as to the overall finish and presentation of each. Be aware of the importance of finish and presentation and of the significant quantity of marks allocated to each

- reflect on and incorporate the processes and techniques they have experienced during their course work; keep designs simple and compliant with the brief, and ensure they have the range of the skills necessary to see it through to completion.

4. Written Examination – Ordinary Level

4.1 Introduction

At Ordinary Level, the written examination is allocated 200 marks. This equates to 40% of the overall mark allocation for the subject at this Level. In 2011, a total of 1,121 candidates sat the written examination in Engineering at Ordinary Level. This represents 21.8% of the cohort who sat Leaving Certificate Engineering. A total of 77 (7.0%) of these candidates were female.

The structure of the examination paper is as follows:

- Question 1, a compulsory question, consisting of:
    - Section A – (30 marks) - candidates are required to attempt any six from eight parts
    - Section B – (35 marks) - candidates are required to attempt any three from five parts
- Questions 2 to 7 - candidates are required to attempt any three questions. Each question is worth 45 marks

The time allowed for the examination is two hours and thirty minutes.

Examiners reported that the use of graphics throughout the paper encouraged candidates to engage with the examination.

4.2 Performance of Candidates

Table 12 below shows the percentage of candidates achieving each grade in the Ordinary Level written examination for the years 2009 to 2011.

Year	Total	A	B	C	*ABC*	D	E	F	NG	*EFNG*
2009	**1309**	8.0	22.1	26.5	***56.6***	27.3	9.8	5.2	1.1	***16.1***
2010	**1173**	8.0	21.7	26.7	***56.4***	28.1	10.9	3.7	0.9	***15.5***
2011	**1121**	8.0	22.5	29.3	***59.8***	25.2	11.2	3.4	0.5	***15.1***

Table 12: Leaving Certificate Engineering (Ordinary Level) - written examination grade outcomes 2009 -2011

Note: *The grades awarded to candidates in Leaving Certificate Engineering are computed from the combined results of the relevant components completed by candidates*.

An analysis of the grade distribution for 2011 shows little variation in the distribution of grades over the past three years at Ordinary Level. The percentage of candidates achieving a C grade or higher has increased by approximately 3% from 2009 and 2010. An analysis of all scripts showed that 31.3% of candidates attempted more than the required number of questions. This represents an increase from previous years. Furthermore, examiners noted an increase in the volume of written content in 2011 compared to previous years.

4.3 Analysis of Candidate Performance

The following commentary, which is based on the reports of examiners, should be read in conjunction with the relevant examination papers and marking schemes, which are available on **www.examinations.ie**.

Table 13 below shows the frequency of attempts and average mark achieved per question. These and all following statistics are based on an analysis of 74% of all scripts.

Question	Attempt (%)	Average mark	Popularity
General Knowledge	n/a	41.1	Compulsory
Metal Production	57.2%	19.8	4th
Heat Treatment	77.4%	25.2	1st
Fabrication	59.7%	23.4	2nd
Plastics	58.9%	20.6	3rd
Machining	53.4%	24.6	5th
Metrology	44.5%	21.0	6th

Table 13: Leaving Certificate Engineering (Ordinary Level) 2011 - Frequency of attempts and average mark by question

Examiners noted that a number of Ordinary Level candidates continued to demonstrate poor examination technique. For example, some candidates, while attempting all questions, left many parts of these questions unanswered. Other candidates attempted more than the required number of questions, while 10.2% of candidates attempted less.

Question 1: Section A and Section B

Attempt Rate: 100% (from sample)   Average mark: 41

Question 1: Section A

(a) Examiners noted that candidates demonstrated a very good understanding of the relevance of the safety sign shown on the examination paper.Many candidates' responses referred to using the lathe / drilling machine or to identifying dangerous working procedures / areas.

(b) This part was answered by the majority of candidates. Examiners noted that responses were only fair. Many candidates incorrectly identified bronze as the alloy.

(c) This part was well answered and candidates, in general, displayed a good understanding of the use of a counter sinking drill. However, a small number of candidates made reference to using it for a pilot hole, and lost marks accordingly.

(d) Many candidates provided the type of thread but did not include an application. Some candidates described the tapping process rather than the thread type.

(e) This part was well answered. Examiners felt that candidates may have benefitted from the knowledge gained while working on the Technology Project.

(f) This part proved popular, but the accuracy of candidates' responses varied. Many of the successful responses included zinc coating, and references to prevent rusting / corrosion were also common. Some candidates offered suitable applications.

(g) This was a popular selection and was well answered. Reduction in manufacturing cost and better accuracy were popular responses. A small number of candidates referenced advantages in product design.

(h) This part was less popular and often elicited poor responses. Some candidates confused the given gear mechanism with the rack and pinion.

Question 1: Section B

(i) The majority of candidates selected the Lathe tailstock and scored well in this part. The function of the tailstock was clearly understood by the majority of candidates and many included good to fair descriptions of operating features. A small number of candidates used diagrams to good effect.

The ratchet and pawl was the second most popular choice in this part. The majority of candidates provided descriptions for function but difficulty arose when describing the operating features. Some candidates provided answers which were too brief, such as stating that the ratchet and pawl only moves in one direction. Candidates who used diagrams to support their answers usually scored well.

The micrometer was the least selected of the three items in this part. In general, candidates provided weak descriptions on the operating features of the micrometer. Many candidates referred only to the application of the micrometer for measurement.

Responses were generally too brief and lacked sufficient detail. Better use of diagrams in support of answers would also have contributed to higher scores in this section.

(j) This part was selected by the majority of candidates and most scored well. Many candidates demonstrated a good level of knowledge in computer terminology. It was evident that candidates were very familiar with both wireless connection and the USB key. Video conferencing, when selected, was well answered, with the inclusion of webcam and the use of Skype prominent in the responses. Graphics card was the least popular choice. Candidates who limited their answers to two or three words did not score well, as greater detail was required for full marks.

(k) This part was not frequently attempted and many candidates who did attempt it gave partial responses. In general, candidates defined elasticity well but some candidates found it difficult to relate elasticity to metals; many provided the example of a rubber band instead.

(l) In this part, engraving and the parting-off tool were the most popular choices. Many of the responses were, however, somewhat vague or too brief. The printed circuit board was not a popular choice and was often not well answered.

(m) This part was popular and many candidates answered here having already attempted the required three parts in Section B. The majority of candidates provided the name centre drill. The explanations for its function varied in standard. Some of the weaker responses offered countersinking as a function.

Question 2

Attempt Rate: 57.2% (from sample) Average mark:20

This was the fourth most popular of the optional questions, but the standard of answering was generally poor.

(a) Candidates performed well when naming the furnaces but many lost marks when stating the function of the furnace. Many candidates mixed up the functions of each of the three furnaces. Candidates particularly displayed a poor understanding of the cupola furnace.

(b) This part was attempted by most candidates but very few achieved full marks. Candidates displayed a good level of knowledge regarding high carbon steel. However, responses to metal ore, tinplate and tuyere were often inaccurate and many lacked sufficient detail to achieve high marks.

(c) Candidates performed well in this part, with many excellent responses.

(d) This part was well answered and many candidates displayed a high level of understanding of metal alloys.

Question 3

Attempt Rate:77.4% (from sample) Average mark:25

This was the most popular optional question and it also achieved the highest average mark. This does not match the trend of previous years where the question on heat treatment was generally less popular and not well answered. Examiners stated that the inclusion of the graphic on the centre punch may have provided the stimulus for candidates to attempt and display their knowledge on heat treatment and metal properties.

(a) Parts (i) and (ii), on hardening and annealing, were the most frequently selected and the standard of answering varied. The successful candidates differentiated between the heating and cooling requirements in each of the heat treatment processes and the outcomes regarding the properties of the metal after heat treatment. Part (iii), on tempering, was generally less successfully answered.

(b) (i) Examiners reported that candidates actively engaged with this part of the question. Some common reasons outlined were 'incorrect heat treatment' of the centre punch and 'incorrect use of the centre punch'.

(ii) A variety of suggestions were offered. Most candidates did not refer to heat treatment and many failed to display any significant knowledge or detail in their responses.

(c) This part was well answered and candidates achieved full marks in most cases. The 'use of protective clothing/equipment' was frequently referred to in candidates' responses. Some candidates referred to 'safe working procedures'.

(d) This part was well answered, with most candidates opting for brittleness and conductivity. Some candidates confused malleability with ductility.

or

(d) This option proved popular this year and was well answered. Common applications provided were 'the use of an air-drill, or 'the suspension found in trucks'.

Question 4

Attempt Rate:59.7% (from sample) Average mark:23

Candidates who attempted this question tended to give answers to all parts and, in many cases, demonstrated a very good working knowledge of joining techniques.

(a) (i) This part was well answered.

(ii) The responses to this part were rather uneven and not all candidates provided the correct proportions.

(b) Some excellent responses demonstrating a good understanding of the joining processes, and of the safety involved, were in evidence here. The majority of candidates demonstrated a high level of knowledge, with many attempting more than the required three. In many cases, candidates received full marks.

(c) Most candidates answered part (i) 'oxides', and part (ii) 'passive flux' to good effect. However, some candidates were not always clear on the limitations of a passive flux. Part (iii) on 'tinning' was often well answered. Some of the responses provided for part (iv), 'chemically clean', indicated a low level of understanding of this topic.

(d) Most candidates displayed a high level of understanding of the safety requirements associated with brazing and of the the dangers involved. Full marks were awarded in many cases.

Question 5

Attempt Rate:58.9% (from sample) Average mark:21

This question was the third most popular and scored the second lowest average mark for the optional questions.

(a) This was very well answered by most candidates. In part (i), a minority of candidates identified 'compression moulding'instead of 'vacuum forming' for process A. Some candidates used the given diagrams to support the description required in part (ii). Most candidates suggested an end product for each of the processes, as required in part (iii), and this increased their chances of scoring high marks.'Car body' and 'bottles' were popular responses.

(b) This part was reasonably well answered where some responses focused on the environmental issues associated with the disposal of plastics. In many instances, candidates confined their answers to handling plastics in a workshop environment.

(c) Candidates were required to attempt three of the four parts and, generally, scored well. The most popular choices were 'adhesives', 'strip heating' and 'laminating'. However, laminating was not always answered in the context of plastic manufacturing and explanations for 'dip coating' were somewhat inconsistent.

(d) The majority of candidates provided one correct plastic. Some candidates suggested 'thermoplastic and thermosetting plastic' or products made from a thermoplastic.

Question 6

Attempt Rate:53.4%(from sample) *Average mark:25*

This was the second least popular question but candidates who attempted it were reasonably successful.

(a) This was very well attempted by most candidates. The majority of candidates correctly identified the three jaw chuck and the four jaw chuck. In part (ii), a tailstock was often provided for the fixed steady. Very few correct answers were given for the faceplate.

(b) (i) Candidates scored well in this part and demonstrated a good basic knowledge and understanding of cutting fluids in machining. Successful answers included 'cooling the cutter' and 'lubricating the work piece'.

(ii) In this part, full marks were awarded in most cases.

(c) (i) Many candidates did not correctly identify both cutting-tool angles.

(ii) When attempted, responses were rather mixed and many candidates failed to demonstrate a detailed understanding of this aspect of cutting-tool geometry.

or

(c) This section was not frequently answered. Candidates who did attempt it tended to just expand briefly on the abbreviations, especially for CAD and CNC.

Question 7

Attempt Rate: 44.5% (from sample) *Average mark:21*

This was the least popular question. Examiners noted that some high-achieving candidates attempted this question.

(a) The majority of candidates achieved full marks for the names, but many did not include the descriptions.

(b) Many candidates were successful with the calculations in parts (i), (ii) and (iii).

Part (iv) provided the greatest challenge for some candidates.

(c) Many candidates did not opt for this section. The'vernier height gauge' and the 'feeler gauge' were identified correctly, in most cases, but applications were sometimes omitted. The answering was inconsistent regarding the 'plug gauge' and the 'surface plate'.

or

(c) This section was frequently answered. Candidates provided good drawings of the circuit symbols in question.

4.4 Conclusions

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

- Examiners noted that a high percentage of candidates (31.3%) attempted an extra question or questions.

- Approximately 10.2% of candidates did not attempt the required four questions and some candidates failed to answer all of the required parts within individual questions.

- Examiners noted an increase in the volume of written content compared to previous years. However, some candidates, when asked for descriptions or explanations, provided answers that were too brief and lacked sufficient detail.

- Examiners noted that some candidates demonstrated a poor knowledge of ferrous metals, non-ferrous metals and the metal producing furnaces.

- From an analysis of the results attained, it would appear that some candidates devote a disproportionate amount of time to the technology project and that this might have been to the detriment of the written examination.

4.5 Recommendations to Teachers and Students

It is recommended that teachers:

- advise students to continue to develop their examination technique, paying particular attention to the importance of attempting Question 1, Sections A and B, and any three other questions
- encourage students to answer all parts of the attempted questions
- encourage students to read the full examination paper at the start of the examination, before attempting any questions
- advise students to continue to develop their knowledge of ferrous metals, non-ferrous metals and the metal producing furnaces
- increase, where possible, the number of practical hands-on opportunities for utilising equipment and processes available in the engineering room, and continue to support learning by providing regular practical demonstrations
- ensure that students are familiar with the requirements of the written examination
- encourage students to provide more detailed answers in response to question cues such as ‘describe’ or ‘explain’
- encourage students to familiarise themselves with past written examination papers, marking schemes and sample solutions. These are available on the SEC website **www.examinations.ie**
- advise students to use the full allocation of time to sit the examination.

It is recommended that students:

- familiarise themselves with the overall structure and layout of the paper
- read all the examination questions carefully at the beginning of the examination
- attempt Question 1, Sections A and B, and any threeother questions, and thus maximise their chances of doing well in this component
- continue to develop their knowledge of ferrous metals, non-ferrous metals and the metal producing furnaces
- continue to improve their knowledge of equipment and processes in the engineering room
- take sufficient time in the examination to provide more detailed answers in response to question cues such as ‘describe’ or ‘explain’
- ensure that they are familiar with past examination papers, marking schemes and sample solutions. These are available on the SEC website **www.examinations.ie**

- use sample solutions to practise and become familiar with the required techniques and terminology associated with the Ordinary Level written examination. Note the significance of common question cues such as, for example, ‘name’, ‘identify’, ‘outline’, ‘list’, ‘explain’, ‘describe’ and ‘state’

- ensure that they spend an appropriate and proportionate amount of time preparing for the written examination

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

5. The Practical Skills Examination – Common Level

5.1 Introduction

The Engineering Practical Skills Examination consists of the following: interpreting a drawing, marking out, processing, finishing and assembling a test piece to a given specification, according to the examination paper issued by the SEC. The Practical Skills Examination, which is offered at Common Level only, has a mark allocation of 150. This represents 25% of the total marks available at Higher Level and 30% of the total marks available at Ordinary Level. This examination, which is of six hours duration (taken in two three-hour sessions), takes place in schools in May.

On completion, all test pieces are sent to the SEC, in Athlone,where they are marked by a team of examiners who are appointed, trained and monitored by the SEC. The test pieces are marked by application of the marking scheme (Appendix I) in conjunction with high-precision gauges, specially designed and manufactured for the marking process.

A total of 5,089 candidates presented for the Practical Skills Examination in 2011. Examiners commenced the marking process in the SEC, Athlone on Monday 20th June 2011, and it was completed on Friday 24th June 2011. An Advising Examiner monitored the work of each examiner during the marking process in order to ensure accuracy and consistency in the marking process.

5.2 Performance of Candidates

A summary of the results achieved by candidates in the Engineering Practical Skills Examination for the years 2009 to 2011 is presented in Table 14 below.

Year	Total	A	B	C	*ABC*	D	E	F	NG	*EFNG*
2009	**4897**	19.4	43.0	26.0	***88.4***	9.1	2.0	0.5	0.0	***2.5***
2010	**5003**	18.7	43.1	26.7	***88.5***	8.6	2.4	0.5	0.0	***2.9***
2011	**5089**	19.2	43.4	24.0	***86.6***	9.1	3.5	0.6	0.1	***4.3***

Table 14: Leaving Certificate Engineering (Common Level) Practical examination - grade outcomes 2009-2011

Note: *The grades awarded to candidates in Leaving Certificate Engineering are computed from the combined results of the relevant components completed by candidates.*

The achievement of candidates in the practical skills examination in 2011 was very much in line with previous years. Examiners noted that the quality of the practical test pieces was comparable with recent years. There has been a 4% increase in the number of candidates attempting the practical skills examination over the past three years. Examiners noted that candidates were, generally, very well prepared for this examination and they commented on the very high level of practical skills displayed in many of the finished practical test pieces.

5.3 Analysis of Candidate Performance

The following commentary, which is based on the reports of the examiners, is intended to aid teachers and candidates in preparation for future examinations. This section should be read in conjunction with the relevant examination papers and marking schemes, which are available on **www.examinations.ie.**

The examination assesses a range of practical skills and competencies, as specified in the syllabus. This year's examination was similar in style and format to previous years. It incorporated many self-testing features that pinpointed some inaccuracies in the candidates' work. The examination required candidates to manufacture smoothly interlocking and moving parts on both sides of the main polycarbonate mounting plate.

In excess of 95% of the candidates assembled the mechanism in the allotted time, with the higher scoring candidates providing a fully functional test piece, manufactured to a high degree of accuracy and level of finish. Examiners reported that the examination provided ample opportunity for candidates to demonstrate skills in precision filing, drilling, machining, fitting and accuracy, using a good range of materials. The test was relatively straightforward, to mark out with no hidden difficulties. A high level of accuracy was required for the model to function properly and for candidates to achieve a high score.

A minority of candidates found the accuracy and detail required challenging, resulting in some unfinished examination models. The accurate filing of parts was essential, particularly the filing of internal shapes of combined curved and straight surfaces.

Preparation of materials prior to the examination:
During October 2010, the SEC issued instructions to teachers and directions to candidates regarding the equipment and materials required for the practical skills examination and regarding the preparation of materials prior to this examination. In general, the preparation of materials was of a high standard but some candidates lost marks due to poor dimensional accuracy in the prepared blanks. In a number of test pieces,examiners noted evidence of poor finishing and inaccuracies on machined components. In this regard, there was a distinct contrast between CNC produced components and those completed on manual machines.

Examiners noted that the quality of the mild steel plate (part 2) was a very good indicator of the quality of the candidates' skill, and this was often reflected in the overall finished test piece. This piece was quite challenging and it was noted that a large number of these parts were inaccurate and poorly filed and finished by some candidates, despite having adequate preparation time to do so. A minority of centres failed to apply a suitable rust preventative spray to prevent corrosion of the mild steel blanks, resulting in poor appearance of finished piece. Candidates who prepared the pre-examination parts to the correct dimensions and required finish secured the allotted marks. The importance of teacher supervision during this process is critical, as inaccurate blanks and poorly machined parts result in a significant loss of marks.

Assembly Function and Finish:

The full operation of the mechanism required a high degree of accuracy in marking out and manufacture as it contained rotating, sliding and oscillating parts. All of these had to move in conjunction with one another in order for the mechanism to function correctly.

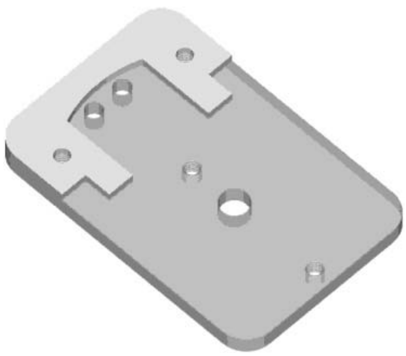
The majority of test pieces examined were assembled correctly, with the mechanism functioning to different degrees of freedom. Accurate profiles and finish of parts 3, 4 and 5 produced on the day were fundamental in achieving complete operation of the mechanism and poor quality work here impacted on the overall grade achieved.

High quality finishes on components may significantly improve efficiency in movement, the potential for accurate assembly, and the overall appearance of the test piece. It is clearly stated on the examination paper that accuracy, finish and function are important elements in this examination and each are awarded a significant allocation of marks.

High achieving candidates produced quality work with all the essential elements completed accurately, while still paying attention to details such as drawfiling cut edges, de-burring and surface finish of parts. Some candidates lost marks due to poor filing accuracy in particular, as well as failing to adequately finish components.

Parts 1 & 3

Part 1 and Part 3 were considered together for marking purposes with both components straightforward to mark out. Part 1, the polycarbonate component, was generally well made and finished, with the accurate location of the drilled holes being critical to allow the range of movement of the added components. Part 3, made from aluminium, provided a more challenging filing exercise with the candidate having to pay particular attention to the 10mm × 10mm recess as well as the accurate filing of the internal 32mm recess and adjacent R44mm curve.



Candidates lost marks due, generally, to one or more of the following factors:

- Dimensional inaccuracy in the blanks
- Poor accuracy in the Slot shape in Part 3, particularly where the curve and straight lines intersect
- Poor accuracy, filing and finish to the 10mm radii on the corners. These need to be blended to adjacent surfaces
- Inaccurate location of the M5 and/or Ø10mm holes, resulting in misalignment of parts when fitted, and affecting the movement of the mechanism.

Part 4:

The accurate production of this brass component provided a challenge to all candidates and was an important component in the successful operation of the mechanism. While the marking out was straightforward, the filing required a high level of skill as it included internal, curved and straight surfaces as well as having to match the external 32mm piston head to Part 3.

From observation, the filing of the 20mm slot was particularly challenging for some candidates and this fact was reflected in the quality of the completed pieces presented for grading. Typically, marks were lost due to the following factors:

- Inaccuracy in marking out general shape
- 32mm piston head undersize and curvature poorly produced, resulting in a poorly fitting part
- 20mm slot poorly filed with intersection between straight edge and curvature inaccurately produced
- Radius 3mm recesses poorly produced or not present at all
- Poor surface finish on part, including lack of drawfiling on filed surfaces.

Part 6:

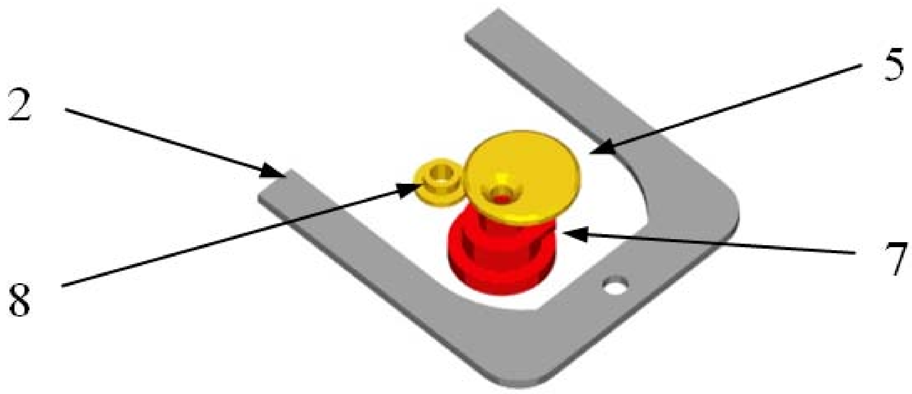
This element was one of the more challenging components for candidates to complete. The accurate marking out of this part was crucial in gaining marks for both shape and function, with the location of the Ø8mm being particularly important for correct operation. However, this part also required substantial accuracy in filing, with the curved head and the 20mm × 24mm slot proving the most problematic. The slot accuracy was vital in relation to the rotation of Part 7 within it and needed particular attention. A number of candidates failed to provide the R3mm fillets in the end of the slot. Marks, in general, were lost due to:

- Inaccurate marking out and poor dimensional accuracy, including incorrect location of the Ø8mm hole
- Poor accuracy and shape of curved head, including the lack of or incorrect location of R3mm fillets associated with it
- Lack of parallelism in slot and poor dimensional size
- Failure to provide 3mm fillets on internal corners of 20mm slot
- Radius 11mm curves poorly shaped.

Parts 2, 5, 7 and 8:

These components were part of the pre-prepared pieces and, in general, these components were well prepared and present in the majority of candidates' work. The mild steel plate here provided both a physical challenge as well as an accuracy challenge, with the internal R26mm curves important in relation to the function and appearance of the finished mechanism. However, examiners noted that some of the mild steel parts were distorted, during either filing or the stamping of the examination numbers, which resulted in these sitting poorly on assembly.

The majority of candidates lathe work was complete. Part 7 was particularly challenging. Examiners noted that some candidates poorly completed the filing of the cam element on Part 7.



Marks were lost in this section due to the following:

- Inaccurately filed internal curves on the mild steel part
- Poor accuracy and completion of the external radii
- Failure to counter drill the M5 hole in part 7
- Failure to provide required chamfers on lathe pieces
- Failure to provide anti-corrosive coating on the mild steel component resulting in poor appearance/finish.

5.4 Conclusions

- Candidates were, generally, well prepared for the Practical Skills Examination and the overall result reflects this.

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

- The quality of each individual component affected the degree of success achieved in the overall assembly of the examination test piece.

- Examiners noted that poor marking out may have led to inaccurate drilling, shaping, and assembly, and may also have led to the ineffective functioning of the examination test piece.

- The absence of a rust preventative on the steel part, which led to rusting, greatly impaired the overall appearance of the test piece in some instances.

- In some cases the quality of finish was unsatisfactory.

5.5 Recommendations to Teachers and Students

It is recommended that teachers:

- ensure that appropriate time provision is made for teaching and learning the skills associated with the Practical Skills 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

- ensure that students are aware that accuracy, finish and function are key objectives 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 jaw marks on the examination piece

- ensure that when using steel, only bright mild steel blank is used, that this is cut on a power saw, not a guillotine, and that it is given a light coating of lubricant WD40 or similar spray

- ensure that laser technology is not used for manufacturing components

- advise students to use only materials and equipment specified on the materials list, M74AML1, issued by the SEC for the Practical Skills Examination

- ensure that the student's examination number is clearly stamped or engraved in the position indicated on the drawing

- remind students in advance that they must hand up the examination paper to the superintendent at the end of the examination.

Note: Since a bar coded and a labelled sealed plastic bag is provided for each candidate, it should not be necessary to also attach tie on labels. These incur a time loss during the marking process, 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 of the examination and check the marking out for accuracy prior to commencing the process

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

- be aware that accuracy, finish and function are key objectives in the Practical Skills examination

- allocate sufficient time prior to the examination to prepare or part-prepare as appropriate the examination components specified in *M74A ML2, Directions to Candidates*

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

- use only the materials and equipment specified on the materials list, Circular M74A ML1, for the Practical Skills Examination

- make sure to have the examination test piece assembled properly as specified on the examination paper

- use the full six-hour time allocation available for the examination. For example, on completing the assembly and functioning of the examination model, any remaining time could be used for final finishing and polishing

- return the examination paper to the superintendent at the end of the examination.

6. Technology Project: Design- Higher Level

6.1 Introduction

The Technology Project: Design was developed to assess a range of skills and competencies as specified in the syllabus. Project briefs 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'. Project work accounts for 25% of the total marks available at Higher Level, where candidates are asked to submit a model and a design folio. All projects must be the individual work of each candidate, and must be carried out under the supervision of the class teacher

In 2011, a total of 4086 candidates submitted the Technology Project: Design. Candidates were required to design and make a model of a snowmobile to the general specifications outlined in the 2011 examination paper, M74(B).

In this context, and in general, examiners reported positively on the nature and the level of the candidates' solutions to the given brief. Examiners noted the display and diversity of design skills communicated in the folio, coupled with excellent demonstrations of practical skills in model snowmobiles. These were manufactured to high standards, using a wide variety of engineering processes. There were many examples where candidates demonstrated levels of excellence in creativity, innovation, problem-solving and communication. Examiners also noted that, in the realisation of the model, bench and manufacturing skills were executed to great effect, with high levels of accuracy and finish inherent. However, it was also reported that, in some instances, the skill level and quality of work presented was inconsistent and the standard of finish and presentation of both the model and folio could be further improved.

Projects were marked by application of the marking scheme issued as part of the project brief in October 2010. The marking process commenced in schools on Tuesday 7th June 2011 and was completed on Friday 17th June 2011. As part of the quality assurance processes, an Advising Examiner monitored the work of each examiner during the marking process in order to ensure accuracy and consistency in the marking process.

Examiners noted that, in most centres, candidates had put considerable effort into the layout and presentation of the manufactured models and folios. Such an approach values the effort of the candidates and provides a showcase within the school for the creativity and skills of the candidates.The SEC acknowledges the assistance of the Engineering teachers and the school authorities in the preparation and layout of centres for marking the projects.

6.2 Performance of Candidates at HigherLevel

A summary of the results achieved by candidates in this component at HigherLevel for the years 2009 to 2011 is presented in Table 15 below.

Year	**Total**	**A**	**B**	**C**	***ABC***	**D**	**E**	**F**	**NG**	***EFNG***
2009	**3770**	22.5	29.1	24.4	***76.0***	15.3	5.9	2.5	0.3	***8.8***
2010	**4043**	21.7	32.6	25.5	***79.9***	13.3	4.2	2.3	0.3	***6.8***
2011	**4086**	21.7	31.2	26.1	***79.0***	13.9	4.5	2.3	0.4	***7.1***

Table 15: Leaving Certificate Engineering (Higher Level) Project - grade outcomes 2009-2011

Note: *The grades awarded to candidates in Leaving Certificate Engineeringare computed from the combined results of the relevant components completed by candidates*.

There has been an 8.4% increase in the number of candidates attempting the Higher Level project over the past three years. The grade profile of the final results is in line with those of recent years.

Examiners noted that some candidates who opted for the Higher Level project would have been better suited to Ordinary Level.

6.3 Analysis of Candidate Performance at HigherLevel.

The following commentary, which is based on the reports of the examiners, is intended to aid teachers and candidates preparing for future examinations. This section should be read in conjunction with the relevant examination papers and marking schemes, which are available on **www.examinations.ie.**

The Technology Project: Design, at Higher Level provided an opportunity for candidates to display their skills in design, initiative in planning, idea formulation and development, and practical techniques and processes.

Candidates showed a high degree of engagement with this project. Successful candidates availed of the opportunity to demonstrate the full diversity of design skills, coupled with their bench and manufacturing skills. In general, examiners noted the wide range of models produced, with high levels of accuracy and finish inherent.

Project management is crucial for a successful outcome, especially when constrained by time and by elements of the brief. It was evident, from the folios of successful candidates, that a structured process was implemented from analysing the brief (brainstorming), to investigating a number of possible solutions, to mock up or modelling solutions, to selecting a final solution, to manufacturing the model using a work plan in conjunction with well produced working drawings and testing, and to evaluating continuously throughout the process.

However, some candidates presented work displaying little evidence of good design in the folio and/or in the model. It was the view of many examiners that some candidates more suited to Ordinary Level opted for the Higher Level project. Many of these candidates scored less well at this level, as the range of design and manufacturing skills required for Higher Level is more demanding than for Ordinary Level. This may also be linked to the issue of some candidates failing to submit a folio. At Higher Level it was noted, from an analysis of all projects at this level, that 8.7% of candidates failed to submit a folio.

The following commentary includes an analysis of the individual sections from the marking scheme, which is based on the reports of the examiners. This section should be read in conjunction with the relevant examination paper. This includes the marking scheme for this component which is available on **www.examinations.ie.**

The Folio –Design Process (40 marks)

The folio records the work of the candidate and should contain all the details of the design process, from the initial ideas to the final evaluation. The folio should be developed in tandem with the model and should contain a complete contemporary record of work-in-progress. 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'.

The more successful candidates had carefully read the Design Brief and the Marking Scheme in the examination paper and followed the directions therein. They produced a concise design folio, detailing all aspects of their work and often displaying excellence in terms of content and presentation. However, examiners reported that a significant percentage of folios were poor and there were common errors and challenges which are highlighted in the sections outlined below.

Analysis of Brief:

A successful end product will usually result if all the requirements of the design brief are clearly identified and understood before any detailed design work begins. 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 combinations. This will demonstrate that they fully understanding all the challenges presented by the design brief.

Many candidates successfully completed this section of the folio using a wide range of approaches to communicate this detailed analysis. However, some candidates reproduced the wording from the issued design brief and failed to elaborate on any of the specified criteria. Some candidates also confused analysis with investigation of possible solutions. Teacher guidance is essential here, as this is the first stage of the design process and candidates need time, for brainstorming and discussions, to be clear on all the requirements and specifications demanded in the design brief from the outset.

Investigation of possible solutions:

The moment a designer is presented with a problem, many possible solutions will present themselves. For this section, candidates are required to develop at least three potential solutions (one of which may become the final solution) in order to satisfy the design brief.

Good investigation and research may include the following:

- using internet research or books to obtain ideas
- sketching these ideas towards forming a final solution, or elements of a final solution
- visual inspection of existing models for ideas and proper dimensional proportions
- talking to people involved in manufacturing, use or sales of existing models
- using a variety of modelling techniques including mock-ups/models of ideas/final solution
- using CAD to model potential solutions.

All evidence of this planning/research should be communicated by inclusion in the folio.

Candidates used a variety of successful approaches in the development of these potential solutions. Some produced three complete solutions satisfying all criteria and specifications in the design brief. Others took the individual criteria or specifications from the brief, for example ‘Incorporate a front ski with steering mechanism’, 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. In some cases this section of the folio was not completed satisfactorily, and candidates failed to produce clear evidence of three ideas.

Candidates who were most successful, used clear sketches, diagrams and a variety of modelling techniques to communicate and formulate their ideas, in order to arrive at a final solution. Modelling techniques, mentioned above, can be a powerful medium to enhance the design process. They can include the use of CAD to simulate designs and the construction of 3D models using cardboard, straws and a variety of household and workshop materials. These techniques were used to good effect to determine what can or cannot be manufactured. This also gave an early indication regarding the size and proportion for the final design. All modeling is part of the design process and should be presented with the final manufactured model and folio. All modelling should be clearly identified with the candidate’s examination number.

Examiners reported that some candidates included superfluous material, often printed directly from the internet. This included large amounts of material about the history of snowmobiles, or descriptions of tools and machinery. Material downloaded from the internet can be useful if correctly related to the final design solution. Candidates must, however, show evidence of analysis or reflective thought when engaging with this material.

Criteria for selection of solution:

This is where the candidate presents a justification for the final solution selected. This is a higher order skill and the teacher’s role is pivotal in developing this skill prior to the beginning of project work. Candidates who were successful presented reasons why their individual solutions satisfied the design brief. Some included a discussion on the merits of the selected final solution, compared to the other possible solutions from the previous section in the folio, in terms of satisfying all criteria and specifications of the issued design brief. Some candidates tabulated a checklist of categories, including all criteria and specifications from the issued design brief. They rated/scored each of three possible solutions under each category. This helped them to select the solution which best satisfied the brief. Examiners noted that this section was challenging for some candidates.

Production drawings/plans:

Good quality dimensioned drawings and a work plan from which the final solution can be manufactured are necessary here. Some candidates used CAD to great effect in this section, including both 2D and 3D presentations. An analysis of the full sample of folios shows that CAD, mainly SolidWorks, was used by a total of 747 candidates (18.29%) at Higher Level. Examiners reported an improvement in the standard of draughtsmanship and presentation compared to previous years. Many candidates used a work plan identifying how the solution was manufactured, including the procedure/processes involved to complement the Drawings. Some candidates included digital images with accompanying text for the various stages of the manufacturing process. Examiners also noted that some candidates produced drawings that were inaccurate, incomplete, poorly dimensioned, and lacking in clarity.

Testing and Evaluation:

Testing: Does the manufactured final solution satisfy the brief? Candidates should test the final solution in terms of satisfying all specifications of the design brief. A brief account of each test should be documented. In a minority of cases, candidates performed and documented simple tests during the design stage, for example testing the electronic circuit or different steering mechanisms. They then made necessary modifications based on the results of these tests. Some candidates tested the final model with regard to all criteria and specifications from the issued design brief, and recorded in tabular form, with straightforward yes/no answer to satisfy each requirement.

Evaluation: Evaluation is dependent on testing and should be a continuous process. The more successful candidates examined the results of various tests and further critiqued the finished model to ascertain where the manufactured model was successful, outlining its attributes and shortcomings and stating any amendments or improvements that could be made. These should be communicated in this section of the folio. For some candidates, the evaluation was in the form of an overall conclusion, referring to time management difficulties and poor planning.

Presentation of the Folio:

Marks are allocated for the presentation 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. Many candidates included digital images as an ongoing record of work in progress, with some candidates including CAD drawing in 2D and 3D. A significant number of candidates provided typed folios. Examiners reported that some candidates successfully used A3 sheets throughout the folio, similar to the presentation technique used for the Leaving Certificate DCG assignment.

The Model - Design Realisation(110 marks)

The more successful candidates had carefully read the examination paper, which includes marking criteria for the model, and followed the directions therein. For a successful final solution,candidates were required to adhere to the following design specifications:

'Design a model of a snowmobile to the general specifications outlined.

The model snowmobile should:

(a) Have the rear propulsion unit controlled by an ON/OFF switch;

(b) Incorporate a front ski with steering mechanism;

(c) Have seating capacity for the driver only.

Presentation of the completed model should ensure that:

(a) All main operating features are clearly visible without dismantling.

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

(c) Electric power does not exceed 9 volts'.

Rear propulsion unit controlled by an ON/OFF switch:

The rear propulsion units generally consisted of single or double rubber tracks mounted on wheels or pulleys and driven by motor and simple gearbox. Helical spiral drives were also used. Many candidates used electronic circuits to provide forward and reverse motion to the propulsion unit.The circuit wiring, including the mounting of on/off switches, were generally safe, neat and tidy. Some candidates manufactured a remote type control unit to operate the model and examiners noted that the execution of this was somewhat varied.

Incorporate a front ski with steering mechanism:

The majority of candidates designed a steering system to operate two skis. Many candidates used very simple but effective steering linkages. Some candidates incorporated rack and pinion mechanisms to good effect. Some of the solutions were elaborate and showcased a diversity of design and engineering skills. Some steering mechanisms incorporated a suspension system and, though not a requirement of the design brief, were very successful in operation. Examiners also noted that some of the steering assembly was loose and lacked stability. This detracted from the overall effectiveness of the model. Candidates designed a variety of handlebars and steering wheels.

Have seating capacity for the driver only:

This aspect was very well addressed. Most candidates included some form of seating with solutions ranging from a simple bend on sheet metal or acrylic to more elaborate designs including a series of bends/folds.Other successful designs integrated the seat into the overall body profile of the snowmobile. In some cases, vacuum forming was used to good effect. Some candidates designed adjustable seats.The seats were predominantly manufactured from acrylic, aluminium or brass.

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

All of the specified constraints were adhered to in the majority of completed models.

Other Observations on the Model

Materials used:

The snowmobiles were generally manufactured from sheet aluminium, brass sheet or acrylic. Many candidates, using sheet metal, produced exceptional profiles, which were aerodynamic and aesthetically pleasing. Some candidates used box, channel and angle section in the chassis structures with the occasional use of wood to profile the front of the snowmobile. Some candidates used acrylic to manufacture effective safety guards for rear propulsion systems. Examiners noted that many candidates used vacuum forming to varying degrees of success.

Assembly techniques:

Models which were well designed were, generally, assembled neatly through the appropriate use of screw threads/ fasteners, thermal joining, and pop riveting. However, some examiners reported the over-use of adhesives in a number of instances. The mechanical efficiency of some mechanisms was compromised by poor assembly. Rear propulsion units were, generally, well assembled. However, for some candidates the assembly steering mechanisms proved more challenging. Electronic wiring was sometimes poorly presented, particularly where additional features like LEDs were added. Insufficient space or lack of appropriate accommodation left wiring exposed in some cases, but in most cases, wiring was neat and tidy.

Examiners noted a wide variety of well-executed, mechanical and thermal joining techniques. Proper execution of these techniques and skills was essential for the smooth and efficient functioning of the snowmobile. Some excellent work was presented, especially in the joining of non-ferrous metals, where pop riveting, countersunk screws, nyloc and cap nuts were widely and appropriately used. These enhanced the final outcome. Candidates who completed the Junior Certificate Metalwork programme would have experienced these non-ferrous assembly techniques in the Project and Practical Examination. There was also evidence of crude assembly. Some examiners reported the over-use of adhesives in a number of centres. The mechanical efficiency of some propulsion and /or steering mechanisms was compromised by poor assembly.

Manufacturing skills:

Examiners noted that, in many centres, the essential practical engineering skills were portrayed to good effect in the manufacture of well-designed models. High standards of accuracy and finish are continually stressed as being of paramount importance in producing a model, and candidates' executions of these were very much in evidence.

In many centres a wide variety of bench and manufacturing skills was employed and standards ranged from fair to excellent. Amongst the many processes employed in the manufacture of models, were high levels of machining (CNC and manual lathe), very intricate folding and bending,drilling, milling, vacuum forming, a variety of joining techniques, electronics, and pneumatics. Modelling techniques were evident in many cases and evidence from candidates' folios demonstrated the contribution modelling made in the design and manufacture of the snowmobiles.

Finish and Presentation:

Examiners noted that, in most cases, high levels of finish and presentation of the model snowmobiles were in evidence. Many candidates put great effort into finishing, polishing and/or spray painting parts before and after assembly. High quality finishes on components may significantly improve efficiency in movement, the potential for accurate assembly, the aesthetic appearance of the component and the overall presentation of the complete model.There is also a significant allocation of marks awarded to finish and presentation of the model.

There were some instances where insufficient attention was given to this aspect of the manufacturing process. Some candidates did not pay attention to de-burring, draw-filing and polishing the external edges of the components.The following is a summary of other instances where poor finish and lack of attention to detail may have resulted in lost marks:

- poorly drilled and unfinished holes
- excessive use of adhesive
- protrusion of long machine screws
- materials left in their raw state
- electronic circuits left incomplete, unfinished or loosely assembled.

6.4 Conclusions

- Examiners noted the diversity of design skills in the creativity, innovation, problem solving, and communication displayed in the compilation of a design folio. The broad range of practical skills required to manufacture the project artefact/model was also in evidence.

- The standard of presentation of the folio was frequently reported as excellent. In some cases, however, there was still room for improvement in the finish and presentation of both the model and folio.

- Some candidates used CAD to great effect in their working drawings – both in 2D and 3D presentations.

- Project management is crucial for developing a successful outcome, especially when constrained by time and by elements of the brief.

- The more successful candidates used clear sketches and diagrams. Many candidates used a variety of modelling techniques to communicate and formulate their ideas, in arriving at a final solution.

- High quality finishes were evident in many completed models. These significantly improved the efficiency in movement, the potential for accurate assembly and the aesthetic appearance of the model. They also contributed to the overall presentation of the model.

- Examiners noted that some candidates demonstrated poor practical skills and submitted models which were manufactured to poor standards.

- Some candidates failed to pay adequate attention to the finishing of each individual component and to the overall presentation of the finished model. Greater attention to finish would enhance a candidate's chance of an improved grade.

- There has been an 8.4% increase in the number of candidates attempting the Higher Level project over the past three years. Examiners expressed the view that some candidates would have been more suited to Ordinary Level.

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

6.5 Recommendations to Teachers and Students

It is recommended that teachers:

- ensure that all students have a full copy of the examination paper for the Engineering – Technology Project: Design, and that they are familiar with and fully understand the *General Instructions to Candidates* and the Design Brief

- continue to validate only coursework completed in school under their direct supervision and according to the instructions issued by the State Examinations Commission. This is to ensure the integrity of the coursework being assessed and upholds the principle of inter-candidate equity. The SEC policy and practice for the acceptance of practical coursework for assessment are outlined in Circulars S68/04 and S69/04. Copies of these circulars are available on the SEC website **www.examinations.ie**

- guide students in planning their work in advance and in devising a basic project management log to assist them in setting targets and in making optimal use of the time spent on project work

- emphasise the importance of completing the folio under the headings outlined in the Design Brief section of the examination paper

- encourage students to develop the range of investigative and research skills and to explore a wide variety of possible solutions before they decide on their individual final solution

- guide students in developing the higher order skills of analysis and evaluation

- emphasise the importance of using modelling techniques to develop a clearer picture as to what can or cannot be manufactured and to get an early indication regarding the size and proportion for the final design

- guide students towards producing working drawings which are accurate and well dimensioned and, where possible, use CAD to enhance this process

- emphasise to students the importance of achieving good finish on each component manufactured and on the completed model, and the significant mark allocation for same

- familiarise students with the requirements of past examination papers in the Technology Project: Design. Students should be provided with regular opportunities to apply the design process which they have learned through coursework

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

- ensure that all students have completed and signed the necessary documentation relating to the coursework before the end of the school year

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

It is recommended that students:

- read the *General Instructions to Candidates,* the *Design Brief*and the *Marking Criteria* which are issued by the SEC with the Engineering – Technology Project:Design, examination paper, and follow these in the execution of their project work

- manage their time carefully so that they do not spend a disproportionate amount of time on project work at the expense of the written component

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

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

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

- avoid the inclusion of superfluous material in the folio, such as internet descriptions of the project being investigated, and show evidence of analysis or reflective thought if engaging with this material

- integrate ICT into the folio using digital media to record the on-going development of the artifact and place particular emphasis on the content, the presentation and the quality of sketching/dimensioned drawings in the portfolio

- use modelling techniques to develop a clearer picture of what can or cannot be manufactured, and to get an early indication regarding the size and proportion for the final design

- pay attention to producing working drawings which are accurate and well dimensioned

- pay particular attention to the finishing of the individual components that make up the project as well as its overall finish and presentation, and be aware of the importance of finish and of the significant quantity of marks allocated to it

- reflect on the processes and techniques they have experienced during their course work; keep designs simple, compliant with the brief and ensure they have the range of the skills necessary to see it through to fruition.

7. Written Examination – Higher Level

7.1 Introduction

At Higher Level, the written examination is allocated 300 marks. This equates to 50% of the overall mark allocation for the subject at this level. In 2011, 3,961 candidates sat the written examination in Engineering at Higher Level. This represents 78.2% of the cohort who sat Leaving Certificate Engineering. A total of 148 (3.7%) candidates were female.

The structure of the examination paper is as follows:

- Question 1, a compulsory question, consisting of:
  - Section A – (50 marks) - candidates are required to attempt any ten from thirteen parts
  - Section B – (50 marks) - consists of five short questions and the candidates are required to answer all five. This section is based on a prescribed topic, notified to the schools at the start of each Leaving Certificate cycle. Candidates are required to research and prepare this topic for the Leaving Certificate written examination.The 2011 prescribed topic was based on 'incinerator technology'.
- Questions 2 to 8 - candidates are required to attempt any four questions. Each question is worth 50 marks.

The time allowed for the examination is three hours.

Examiners noted that the use of graphics throughout the paper encouraged candidates to engage with the examination and often provided a structure for candidates' answers.

7.2 Performance of Candidates

Table 16 below shows the percentage of candidates achieving each grade in the Higher Level written examination for the years 2009 to 2011.

Year	Total	A	B	C	*ABC*	D	E	F	NG	*EFNG*
2009	**3599**	11.8	20.2	28.2	***60.2***	24.8	11.2	3.3	0.5	***15.0***
2010	**3857**	11.9	22.7	25.2	***59.7***	23.3	11.8	4.7	0.5	***17.0***
2011	**3961**	12.5	23.5	25.6	***61.6***	22.2	11.9	3.7	0.6	***16.2***

Table 16: Leaving Certificate Engineering (Higher Level) Written examination – grade outcomes 2009-2011

Note: *The grades awarded to candidates in Leaving Certificate Engineeringare computed from the combined results of the relevant components completed by candidates*.

Outcomes are broadly consistent over the three years. The percentage of candidates achieving an A grade increased marginally on the previous two years. The percentage of candidates achieving a C grade or higher stands at 61.6% and has improved by1.9% from 2010. The combined EFNG rate remains high at 16.2%. This high EFNG rate can be attributed to a number of factors:

- Examiners reported evidence showing that some candidates were unsuited to this level. There was also a reduction in the cohort at Ordinary Level, and some of these candidates may have attempted the Higher Level paper.

- Some candidates attempting this examination did not appear to have the ability in terms of language and reasoning skills to deal with the level of subject matter presented in a Higher Level paper.

- Some candidates displayed evidence of poor examination technique. Some candidates attempted too many questions or attempted less than the required number of questions. Examiners reported some cases where candidates made little effort to answer questions, noting that in some instances, scripts contained only a page or so of content and a small number of scripts were entirely blank

- There was evidence of low levels of preparation by a small percentage of the cohort.

It can be reasonably concluded that many of these candidates would have been better advised to take the subject at Ordinary Level as they failed to demonstrate the requisite skills for the Higher Level examination.There would also appear to be a disproportionate reliance by some candidates on the project and practical examination components to contribute to their overall grade. A more balanced performance across all three components is recommended.

7.3 Analysis of Candidate Performance

The following commentary, which is based on the reports of examiners, should be read in conjunction with the relevant examination papers and marking schemes. These are available onwww.examinations.ie

Table 17 below shows the frequency of attempts and average mark achieved per question. These statistics are based on a comprehensive analysis of 1800 (46%)of all scripts.

Question	Attempt (%)	Average mark	Popularity
1. General knowledge	99.7	77.1	Compulsory
2. Testing of materials	83.6	31.6	1st
3. Ferrous metals	27.3	26.1	7th
4. Non-ferrous metals	46.5	29.9	6th
5. Joining Techniques	78.9	24.1	2nd
6. Polymers	50.0	26.8	4th
7. Machining	46.7	27.6	5th
8. Mechanisms	73.8	32.0	3rd

Table 17: Leaving Certificate Engineering (Higher Level) Written examination - Frequency of attempts and average mark awarded

Further analysis on these scripts revealed that:

- Virtually all candidates attempted the compulsory question (Q.1)
- 69.9% attempted the required four other questions
- 21.9% attempted five or more other questions

- 8.4% attempted three other questions or less
- 0.3% of candidates failed to attempt Q.1 Section B, the research topic
- 0.5% of candidates were awarded full marks in the compulsory question (Q.1).

Question 1

Attempt Rate: 99.7% (from sample)   Average mark: 77.1

This compulsory question was identified by examiners as the one of the main reasons why many candidates achieved high marks in this examination component. This was particularly the case in Section B where excellent insight in answering was in evidence.

Section A

(a) This part was popular and quite well answered. Some candidates effectively reused the diagram in their answer.

(b) This part was reasonably well answered.

(c) This was well answered by many candidates. Most candidates gave three separate methods of protecting against corrosion.

(d) This part proved very successful, with many relevant answers.

(e) This was a popular selection, with most giving appropriate properties. Simple answers such as ‘lightweight’ and ‘strong’ were acceptable.

(f) This was very well answered by most candidates, with accurate examples for both insulators and conductors.

(g) This was a popular choice. Candidates recognised that the essence of the question related to the advantages of tubular steel, but many candidates made reference to the aesthetic properties of the table, chrome-plated steel and Eileen Gray’s design, all of which scored full marks.

(h) This part elicited a mixed response. While HSS and DPDT were adequately answered, there were many poor answers for LCD.

(i) While some candidates used appropriate sketches and were successful, many candidates produced inadequate answers for both ‘interference and clearance fits’.

(j) The standard of answering for this part was frequently poor, with little recognition for Charles Babbage or Frank Whittle, and little knowledge evident of Trevor Baylis.

(k) This was not a popular choice. Few candidates displayed any knowledge of pneumatic components and, instead, tended to give general answers.

(l) This part was well answered with precise answers offered by most candidates.

(m) Answers here were fair, with few candidates making an effective link to properties of the threads illustrated. Some scored well by interpreting the diagrams

Section B

The special research topic is an excellent opportunity for rewarding student research and independent work.This question focused on incinerator technology, which is topical given the impending introduction of incinerator plants and the concerns that such technologies will impact on our lives. This choice of topic proved popular among candidates who demonstrated a very good understanding of the topic.

(n) The majority of candidates scored full marks. Interestingly, candidates referred to the negative and positive impacts on recycling rates for part (iii).

(o) This part was very well answered with good identification of health risks.

(p) Some answers lacked the detail and specific knowledge in relation to the incineration process to achieve full marks. Most candidates scored fairly well by offering general descriptions of the combustion elements.

(q) This part was well answered with the moving grate incinerator explained through reference to the diagram. Some limited answers offered only explanations for A,B,C and D.

(r) This part proved challenging for some candidates.The more capable candidates attempted all three parts of this question.

- (i) Good understanding of W2E.
- (ii) Many significant issues were highlighted.
- (iii) This was the least popular part of the question but was well answered by candidates who attempted it. Answers were frequently accompanied by a sketch.

Question 2

Attempt Rate: 83.6% (from sample)   Average mark:31.6

This section deals with the testing of metal and is still among the most popular of the non-compulsory questions with 83.6% of candidates selecting it. The average mark achieved was 31.6, which was an average increase of 1.1 marks on the previous year.

(a)
- (i) This part was well answered, with most candidates identifying the difference between metal fatigue and metal creep.
- (ii) Most candidates identified Brinell and Vickers hardness tests but there was some confusion on the methods of measurement for both tests.

(b) For most candidates the graph was well drawn on graph paper.

- (i) Good calculations for Young's Modulus were in evidence here.
- (ii) Some candidates drew the proof load line on the diagram from the wrong place but most got 0.1% proof stress.

(c)
- (i) This part elicited some mixed responses.
- (ii) Basic principles were reasonably well answered, but some candidates described x-ray or eddy current testing.

Question 3

Attempt Rate: 27.3% (from sample)   *Average mark: 26.1*

This was the least popular of the optional questions and candidates scored the second lowest average mark of the optional questions. Some candidates who did attempt the question scored fairly well, compared to recent years.

(a) (i) This was well answered with good descriptions and excellent sketches of the induction hardening process. Most candidates scored full marks.

(ii) This part was not frequently attempted and was poorly answered when attempted. Few candidates demonstrated knowledge of the properties of grey cast iron and white cast iron.

(iii) This part was, generally, well answered with some candidates detailing the reasons for stress relieving and the process involved.

(b) (i) The regions of the iron-carbon equilibrium diagram were very well identified.

(ii) Many candidates failed to successfully describe martensite structure. However, some candidates displayed an excellent knowledge in this section.

(c) (i) Most candidates identified the pyrometer and knew its function.

(ii) There were many good interpretations of the sketches in descriptions offered for the operation of the optical pyrometer.

Question 4

Attempt Rate:46.5% (from sample) *Average mark:29.9*

This was the second least popular question on the paper. However, candidates who attempted it scored very well.An analysis of past reports on this examination showed that in the 1999 examination, question four and question three were the most widely answered after metal testing (question two). These are now attempted by the least number of candidates. Examiners noted that fewer candidates are attempting these sections on materials science.

(a) (i) Candidates scored well in this question, demonstrating a good basic knowledge and understanding of allotropy.

(ii) This part was well answered with good descriptions and sketches.

(iii) Many candidates used sketches to good effect in this part.

(iv) Some candidates offered descriptions of bcc and fcc, without reference to brittleness.

(b) (i) The thermal equilibrium diagram was generally well drawn but some candidates omitted the first and last points which were given in the question.

(ii) Most candidates were able to correctly label the five features.

(iii) Most candidates tried to develop the ratio of solid to liquid and did draw the correct lines on the graph. However, candidates frequently found the calculation challenging.

(c) Some precise answers were given here but most did not give enough additional information to merit full marks for dendritic growth.

Question 5

Attempt Rate :78.9% (from sample)   Average mark:24.1

This was the second most popular optional question and had the lowest average mark. Some candidates demonstrated a lack of knowledge of MMA welding and many were unsuccessful in providing detailed knowledge of a range of welding techniques – including Resistance, Electro-slag, Submerged Arc, Oxyacetylene and TIG welding.The average mark achieved by candidates in this question was low compared to recent years.

(a) (i) Some candidates gave poor descriptions, with a lack of specific detail of MMA. Some candidates confused MMA with MIG.

(ii) Many candidates correctly identified the ‘transformer’ and ‘capacitor’, with the ‘rectifier’ often referred to as ‘diodes’. The function for each was not well answered.

(b) (i) The majority of candidates did find three relevant safety features but a number of candidates tended to identify general safety precautions such as gloves, rather than electrical hazards.

(ii) Some examiners noted that candidates tended to give information on keeping the weld area clean rather than identifying specific methods such as flux, inert gas and slag coating.

(iii) This part proved challenging for many candidates.

(iv) This part was well answered, with appropriate information offered.

(c) (i) This part was very well answered, with most candidates giving an excellent level of detail for seam welding and identifying the importance of heat and pressure as well as the formation of the weld. Candidates’ responses were frequently accompanied by good diagrams and relevant applications.

(ii) Descriptions for SAW were less effective and less commonly attempted. Some candidates attempted both parts of this option.

or

(c) This part had been more popular in recent years as many candidates had explored robotic control. The need for specific information produced less successful responses. Candidates, in general, did not demonstrate a basic knowledge regarding stepper motors.

Question 6

Attempt Rate from Sample:50%   *Average mark:26.8*

This question was attempted by 50.0% of candidates. Many candidates who attempted this section showed excellent levels of preparedness.

(a) (i) This part was well answered by candidates, with good descriptions and effective sketches on display in the most challenging part of the question. Some candidates failed to attempt this part of the question.

(ii) This was well answered, with polyethylene usually cited as an example.

(b) This section was very well answered, with many candidates attaining full marks.

(i) There were many successful answers to both parts. Many candidates reused the diagram given in the question

(ii) This part was well answered.

(iii) Most candidates correctly identified appropriate components.

(c) (i) Candidates responses were mixed for this part with many demonstrating insufficient knowledge of the function of a plasticiser.

(ii) This part was reasonably well answered, but a number of candidates referred to filling of holes.

(iii) This part was quite well answered.

(iv) The standard of answering was varied for this part.

(v) This was well answered, with most candidates scoring full marks.

Question 7

Attempt Rate from Sample:46.7% *Average mark:27.6*

This question appears to be difficult for some candidates as it may include content from a wide-ranging section of the syllabus. However, this years' question proved significantly more popular with candidates, with an attempt rate of 46.7%, making it the fourth most popular question.

(a) (i) Some answers were excellent, with safety precautions related directly to the process in question. Somecandidates responded with general workshop safety precautions.

(ii) Candidates responses were mixed for this part. Some were familiar with this content and others were not.

(iii) This part was not frequently answered, but most responses were correct.

(iv) The standard of answering in this part was, generally, very good.

(v) Most candidates who answered this part knew the function of a reamer.

(b) (i) This part was well answered by most candidates, with the majority citing at least one good reason for using tungsten carbide tools. Responses frequently made reference to 'long life or the ability to retain a cutting edge during machining'. Some candidates struggled to identify a second reason.

(ii) This part was well answered.Many candidates explained a relevant advantage.

(c) The milling cutters were usually identified but some of the diagrams of the associated cutting operations lacked clarity, detail and labels.

or

(c) This part proved more popular than in recent years.

(i) CNC safety features were well identified and explained.

(ii) Some candidates did not recognise the term ‘simulation’, but many provided excellent responses.

Question 8

Attempt Rate:73.8% (from sample) *Average mark:32.0*

This increasingly popular question was attempted by 73.8% of candidates in 2011. The content in this question was based on mechanisms and electronics and one part was directly linked to the ‘steering mechanism’ specification in the 2011, Higher Level, Technology Project.

(a) The identification and description of the operation for ‘bevel gears’ was most frequently and successfully answered. The‘roller bearing’ was less popular and candidates’ responses were mixed, with many offeringjust ‘bearing’ or ‘ball bearing’.

(b) (i) This part was well answered, with appropriate advantages given.

(ii) Many candidates achieved full marks for this part,with good diagrams aiding explanations.

(iii) There was frequent misinterpretation as a ‘toggle switch’. Some candidates gave good sketches as well as explanations for the mechanism.

(iv) This part was well answered, with descriptions of function, application, or its circuit symbol offered.

(v) This part was less popular, but was often correctly answered by those who attempted it.

(c) Candidates presented varying degrees of viable solutions to the steering mechanism for the go-kart, usually selecting rack and pinion or linkage mechanisms. A number of candidates produced poor quality sketches that lacked labels or sufficient detail in the explanation. Some solutions offered were clearly not viable.

or

(c) This part was less popular than in recent years.Many candidates who attempted this part demonstrated an excellent knowledge of ‘relays’.

7.4 Conclusions

- Many candidates demonstrated excellent knowledge of the syllabus and very high levels of preparedness for the examination.

- Some candidates demonstrated poor examination technique, such as, for example, attempting more than the required number of questions, failing to answer all of the required parts within individual questions, or leaving sections unanswered.

- The prescribed topic examined in Question 1, Section B engaged candidates and many demonstrated an excellent knowledge and understanding of 'incineration technology'. However, some candidates demonstrated a lack of knowledge of MMA welding and many were unsuccessful in providing detailed knowledge of the range of welding techniques examined.

- Some candidates would have been better suited to the Ordinary Level paper as, in some cases, they were not prepared for the more difficult concepts encountered at Higher Level.

- From an analysis of the results attained, it would appear that some candidates may have devoted a disproportionate amount of time to both the technology project and the practical skills examination. This may have been to the detriment of the written examination.

- Successful candidates gave structure to their answering by, where appropriate, tabulating their answers, using bullet points to highlight and give emphasis, producing neat and accurate graphs, and using sketches and diagrams to illustrate their answers.

- It appeared that some candidates may not have used the full time allocation available to complete the examination.

7.5 Recommendations to Teachers and Students

It is recommended that teachers:

- advise students to further develop their examination technique. In particular, the importance of attempting Question 1, Sections A and B and four other questions should be highlighted

- encourage students to answer all parts of the attempted questions

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

- advise students to continue to develop their knowledge of the full range of welding techniques

- provide opportunities for the further development of the techniques necessary for the efficient answering of the questions posed. Particular attention should be given to common question cues such as, for example,'identify', 'outline', 'compare', 'describe', 'explain', 'distinguish' and 'state'

- ensure students are familiar with the terminology used in past examination papers

- encourage students to familiarise themselves with past written examination papers, marking schemes and sample solutions. These are available on the SEC website **www.examinations.ie**

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

- advise and guide students in making realistic decisions regarding the level at which they sit the subject

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

It is recommended that students:

- familiarise themselves with the overall structure and layout of the paper
- read all the examination questions carefully at the beginning of the examination, taking note of key words before selecting any questions
- note that they must attempt Question 1, Sections A and B, and three other questions
- be familiar with the full range of welding techniques and processes and the diagrams that represent each
- use sample solutions to practise and become familiar with the terminology used in past examination papers and understand the significance of common question cues such as, for example, 'identify', 'outline', 'compare', 'describe', 'explain', 'distinguish' and 'state'
- practise freehand sketching and line diagrams and use appropriate diagrams/sketches to support answers
- familiarise themselves with past examination papers, marking schemes and sample solutions. These are available on the SEC website **www.examinations.ie**
- use sample solutions to practise and become familiar with the required techniques and terminology associated with the HigherLevel written examination
- make full use of the allocated time for the examination.

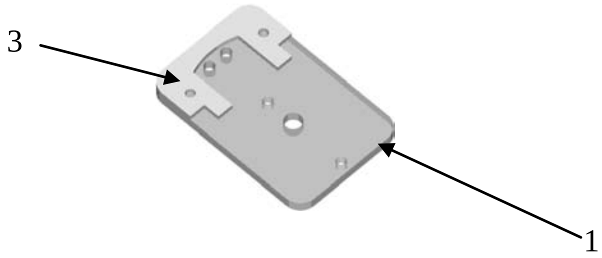
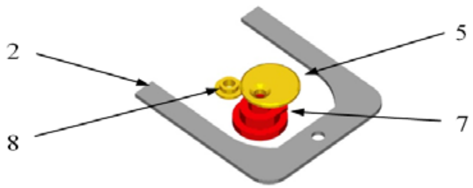
Appendices

Appendix I
Marking Scheme Practical Skills Examination - Common Level

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Engineering Practical Marking Scheme 2011

Subjective Marking 1 - 20 | 17 - 20 Excellent | 13 - 16 Very Good | 9 - 12 Good | 5 – 8 Poor | 1 - 4 Very Poor

Section	Part Number	Pictorial Sketch / Description	Concept		Mark	Mark
1	**All Parts of Project**		Assembly, Function & Finish Subjective Mark 1-20		**20**	20
2	**Parts 1 and 3**		**Part 1**	Marking Out	**2**	20
				10mm Radii	**2**	
				M5 Tapped Holes	**2**	
				Ø10mm and 6mm Holes	**2**	
			Part 3	Marking Out	**2**	
				10mm Radii	**2**	
				10mm × 10mm Steps	**4**	
				Internal Profile	**4**	
3	**Part 4**		**Part 4**	Marking Out	**4**	20
				20mm Slot	**4**	
				44mm Radius	**2**	
				25mm Radius	**4**	
				External Profile	**6**	
4	**Part 6**		**Part 6**	Marking Out	**4**	20
				Ø6mm and 8mm Holes	**2**	
				20mm Slot	**4**	
				42mm and 6mm Radii	**5**	
				External Profile	**5**	
5	**Parts 2, 5, 7 and 8**		**Part 2**	Bench Work	**8**	20
			Part 5	Lathe Work	**4**	
			Part 7	Lathe Work	**4**	
			Part 8	Lathe Work	**4**	

100 Marks(× 1.5 = 150 Total)