JUNIOR CERTIFICATE EXAMINATIONS

1999

MATHEMATICS

ORDINARY LEVEL CHIEF EXAMINER'S REPORT

HIGHER LEVEL CHIEF EXAMINER'S REPORT

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1. INTRODUCTION

1.1 Introductory Comment

The purpose of this report is to provide an overview of the performance of candidates in the Junior Certificate mathematics examinations of 1999. It is hoped that the provision of this information will contribute towards the development and improvement of teaching and learning in mathematics.

The report concentrates on the Higher and Ordinary level examinations. A comprehensive report on the examinations at the three levels, Higher, Ordinary and Foundation, was published in 1996 and also, in 1998. It may be useful for the reader to consult these reports as many of the issues addressed in them were also relevant to the examinations of 1999.

1.2 Junior Certificate Mathematics Syllabuses

The present three syllabuses were introduced in September, 1987. They were first examined in June, 1990.

Amended syllabuses at the three levels will be introduced in September, 2000. The first examination will take place in June, 2003.

1.3 Format of the Examinations

The Higher and Ordinary Level examinations have the same format. Candidates take two papers each of two hours and thirty minutes in duration. On each paper, candidates are expected to attempt one compulsory question and any four out of the five remaining questions.

The Foundation Level examination consists of one paper. Two hours are allowed. Candidates should attempt all questions on the paper.

1.4 Uptake at the Various Levels

The number of candidates sitting Junior Certificate mathematics rose steadily to a peak in 1995. It has declined each year since then. This reflects the changes which have taken place in the size of the overall cohort.

Table 1 below shows the total number of Junior Certificate mathematics candidates each year since 1990 alongside the percentage of the total that sat each of the three levels. There has been a gradual increase in the percentage of candidates taking Higher Level. This figure reached 36% for the first time in 1999. The percentage taking Foundation Level has been dropping slightly, but steadily, since 1991.

Year	Total Number of Mathematics Candidates	% Higher	% Ordinary	% Foundation
1990	58020	31.2	50.7	18.1
1991	60196	30.7	49.8	19.5
1992	62259	29.8	51.2	19.0
1993	64987	31.3	52.0	16.8
1994	66933	33.2	52.0	14.9
1995	67126	34.8	51.0	14.2
1996	66981	35.6	50.9	13.5
1997	66033	35.6	51.3	13.0
1998	64580	35.3	51.8	12.9
1999	61745	36.0	51.3	12.7

Table 1: Uptake at each level since 1990

Table 2 below summarises the gender differences in the uptake of the 1999 examinations. Overall, almost one thousand more boys than girls took the examination. The percentage of girls who took Higher level is noticeably greater than the percentage of boys. The difference in uptake at Ordinary level is small. However, a significantly higher percentage of boys took Foundation Level.

	Number	% of Total	% of Girls/Boys who took Higher	% of Girls/Boys who took Ordinary	% of Girls/Boys who took Foundation
Girls	30 393	49.2%	37.5%	51.6%	10.8%
Boys	31 352	50.8%	34.5%	51.0%	14.5%
Total	61 745				

Table 2:. Gender breakdown of uptake in 1999

1.5 Grades Awarded in 1999

Table 3 below shows the numbers and percentages of candidates awarded each grade in the 1999 examination at the three levels.

	Higher		Ordinary		Foundation	
Grade	Number of Candidates	%	Number of Candidates	%	Number of Candidates	%
A	2974	13.4	2425	7.7	858	11.0
B	6811	30.6	8951	28.3	2516	32.1
C	7107	32.0	10 006	31.6	2377	30.4
D	4196	18.9	7353	23.2	1450	18.5
E	954	4.3	2190	6.9	440	5.6
F	188	0.8	665	2.1	166	2.1
NG	10	0.0	84	0.3	24	0.3
Total	22 240		31 674		7831	

Table 3: Grades awarded at each level in 1999.

Table 4 below shows the percentage of high grades (A, B, C) and low grades (E, F, NG) awarded at each level from 1996 to 1999.

	Higher Level		Ordinary Level		Foundation Level	
	% High Grades,	% Low Grades,	% High Grades,	% Low Grades,	% High Grades,	% Low Grades,
1996	68.1	7.2	72.4	8.2	59.5	10.0
1997	74.2	5.2	73.1	7.5	77.4	5.7
1998	69.1	7.2	66.3	9.6	75.9	5.4
1999	76.0	5.1	67.6	9.3	73.5	8.0

Table 4: % of candidates achieving high and low grades from 1996 to 1999.

An analysis of grades awarded to girls and boys separately indicates that some gender differences existed. Consideration of the top achievers, for example, reveals that the boys outperformed the girls at Higher level. However, the reverse happened at the other two levels. Table 5 below illustrates this.

	Higher	Ordinary	Foundation
Girls	12.3	8.8	11.6
Boys	14.5	6.6	10.5

Table 5: % of Girls and Boys achieving grade A.

In terms of low achievement, there were also differences. The boys fared less favourably than girls at all three levels. Table 6 below shows that the percentage of boys who were awarded grade E or lower was higher than the corresponding percentage of girls in each of the three examinations.

	Higher	Ordinary	Foundation
Girls	4.7	7.5	6.0
Boys	5.7	11.0	9.5

Table 6: % of Girls and Boys achieving grade E or lower.

2. HIGHER LEVEL EXAMINATION

2.1 Question Popularity

The popularity ranking on both papers was similar to previous years with two exceptions.

On paper 1, the algebra question (q.3) was more popular than usual. It was attempted by more candidates than either the area and volume question (q.2) or the quadratic graph and functions question (q.5).

On paper 2, the arithmetic and algebra question (q.2) lost its usual lead position. It was outstripped by the co-ordinate geometry question (q.5).

The order of popularity in answering questions, as indicated by an analysis of a random sample of 4% of the total number of scripts, is indicated in the tables below.

PAPER 1

Order of popularity	Question number	Percentage attempted	Topics
1	1	100%	General
2	4	98%	Statistics
3	3	94%	Algebra - factors, division, solving equations
4	2	93%	Area; Volume
5	5	91%	Quadratic Graph; Functions
6	6	75%	Sets; Algebra - simultaneous equations, problem solving

PAPER 2

Order of popularity	Question number	Percentage attempted	Topics
1	1	100%	General
2	5	96%	Co-ordinate Geometry
3	2	90%	Algebra: Arithmetic
4	6	88%	Trigonometry
5	4	82%	Geometry - theorem and construction
6	3	63%	Geometry - theorem and "cut"

2.2 General Comments

The performance of Higher level candidates was in line with that of the previous two years. Grade A was awarded to 13.4% of candidates. This figure sits comfortably between the corresponding figures of 11.2% in 1998 and 14.3% in 1997. As shown in Table 4, the percentage of candidates who obtained grade E or lower is less than that of 1998 and very close to the percentage in 1997.

The mean overall mark, out of a total of 300, awarded on Paper 1 was 202 (= 67.3%)and on Paper 2 it was 190 (= 63.3%).

The overall opinion of the assistant examiners on both papers was that the examinations were fair and well-balanced. They reported that candidates responded well to the lay-out and the wording of the questions. There was no evidence of ambiguities or misunderstandings.

As indicated by the substantial number of A grades awarded, many excellent candidates presented. These candidates showed a sound understanding of the topics examined and there was evidence that they had a good command of the full syllabus. Also, candidates who presented their work in a clear, detailed and logical fashion deserve commendation. The importance of investing care and attention in the proper layout of answers cannot be overstated. Candidates who do so tend to be justly rewarded as a neat methodical approach facilitates examiners in their attempts to follow the thinking behind the work. It also helps candidates to develop the practice of showing all necessary work.

The 1999 examinations provided further evidence that candidates are becoming more competent in trigonometry. An improvement in the standard of answering in this important branch of mathematics was noted and welcomed in the 1996 Report and again, in the 1998 Report. This is an encouraging outcome and hopefully, this trend will continue. As in other years, candidates performed well in statistics and in work involving quadratic and linear graphs.

Co-ordinate geometry, as usual, was popular with candidates and overall performance was good. However, synthetic geometry continued to be an unattractive option. There was widespread inability to reason out the steps of rigorous proofs and to write them down in a logical and coherent way. Many candidates resorted to indicating information on diagrams when the question required a formal written proof.

The work of many candidates gave cause for concern in terms of overall competence in the basics of mathematics. As highlighted in the 1996 Report and again in the 1998 Report, overall performance tended to be adversely affected by weaknesses in techniques which are essential for a good command of the Higher level course. Assistant examiners noted the following skills as being in particular need of attention:

- simplifying algebraic expressions
- dividing algebraic expressions
- working with percentages
- converting units in the metric system
- substituting into and simplifying the quadratic formula
- dealing with logarithms and indices
- managing square roots
- simplifying surds
- handling decimals
- working with scientific notation
- performing addition and multiplication involving negative numbers
- handling fractions, especially division
- working with functions.

The above list is very similar to that given in the 1998 Report.

The level of low achievement is also a reason for concern. More than a thousand candidates did not reach an overall mark of 38%, that is, grade D or higher. For a Higher level examination, this is too high especially as both papers contained a significant number of straightforward and routine parts of questions.

As in 1998, there was evidence to suggest that significant numbers of candidates were badly prepared in some aspects of the syllabus. On occasions, candidates showed no knowledge of some topics.

2.3 Overview of Questions

PAPER 1

The marks awarded in question 1 were not as high as in previous years. The average mark, out of a total of 100, was 55.4. Only three parts, namely (i), (ii) and (iii), tended to

be very well answered. The parts that caused most difficulty were (iv), (vi), (viii) and (ix).

The marks in question 2 were not as high as would have been expected. The average mark, out of a total of 50, was 34.6. Many candidates incorrectly interpreted what was required in part (a). In part (b), the main problems arose from the use of the curved surface area instead of the total surface area and from failure to cancel π.

Although it was popular, question 3 produced the lowest mean mark for candidates. The mean mark was 29.4 (out of 50). It transpired that almost half (44%) of the attempts at this question became excess questions . Therefore, they were discarded in the final reckoning. The difficulties which candidates had with algebra revealed themselves in this question. Part (b) was described as the worst answered task on the entire paper. Many candidates did not recognise what was required. Others made a series of errors which led them astray. The fact that the quadratic in (c) was not given in standard form caused difficulties which often resulted in incorrect values being assigned to a, b and c.

Question 4 was the most popular of the long questions. It tended to be well answered. It produced a mean mark of 40.5 (out of 50) which was the highest on the paper. However, part (b) did pose problems which arose mainly from lack of proficiency in algebraic skills.

The mean mark awarded for question 5 was 38.8 (out of 50). This made it the second highest scoring question, after question 4. Dealing with the quadratic and linear graphs was straightforward for the majority of candidates. However, part (b), and in particular (b)(ii), was challenging to many.

Question 6 was the least popular on the paper. In spite of this, it produced better returns than question 2 which was the most popular. The mean of the marks awarded to those who attempted it was 31.6 (out of 50). In many cases, candidates seemed to treat it as an excess question insofar as they attempted it last and often left parts of it incomplete. It turned out that 28% of attempts were treated as excess questions. The sets and simultaneous equations parts were well done. However, although candidates were helped by the layout of part (c), attempts to set up the equation were seldom successful and efforts to solve the equations that were constructed abounded with errors.

PAPER 2

The mean mark (out of 100) awarded for question 1 was 64.2. This was higher than in previous years. Parts (i), (ii), (iii) and (viii) tended to be well answered. The applications of theorems, namely, (v), (vi) and (vii), were poorly done. Candidates' performance in part (ix) was often confused. Clearly, candidates lacked knowledge of axial symmetries.

The mean mark awarded for question 2 was 33 (out of 50). Attempts to answer part (a) provided widespread evidence of poor skills in basic algebra. The routine taxation problem in (b)(i) was well answered. However, the rest of the question had a low rate of success but those who managed (b)(ii) usually continued safely to the end of (b)(iii).

The mean mark for question 3 was 22.9 (out of 50). The proof of the theorem was well done by those who attempted it. Part (b) was badly attempted. Candidates showed very

little knowledge of how the theorem should be applied. The outcome was that few succeeded in proving the required properties.

The mean mark for question 4 was 32.5 (out of 50). Again, those candidates who attempted to prove the theorem tended to do so well and they scored highly. The construction of the triangle was generally well done, with accurate measurements and arcs drawn in. In constructing the circumcircle, the arcs of the bisectors were often missing. Very few gave the correct explanation in the final part. The majority failed to recognise the link with the right angle.

Question 5, the most popular and the highest scoring question on the paper, resulted in a mean mark of 33.4 (out of 50). Candidates found this test of basic formulae which was laid out in progressive steps to be straightforward. Arithmetical slips were common particularly where squaring or subtracting involved negative numbers.

The mean mark awarded in question 6 was 31.4 (out of 50). As mentioned earlier, the overall standard of answering this year indicated improvements in trigonometrical skills. Notwithstanding this, there was much inaccurate reading of the tables. The half in the formula for the area of the triangle tended to pose problems. Often, it was ignored. Other times, it was applied twice in the calculation. In part (b), many chose an unnecessarily lengthy approach. For example, they got the third side using Pythagoras and followed this up with the sine rule. In (c), most candidates could not distinguish between the line pq and the line segment pq. As a result, they had difficulty locating the point t.

3. ORDINARY LEVEL EXAMINATION

3.1 Question Popularity

The order of popularity in answering questions, as indicated by an analysis of a random sample of 4% of the total number of scripts, is indicated in the following tables:

PAPER 1

Order of popularity	Question number	Percentage attempted	Topics
1	1	100%	General
2	4	98%	Statistics
3	6	90%	Time/speed problem; Sets; Algebra
4	2	89%	Arithmetic; Area;
5	3	87%	Algebra - linear equation, factors, simultaneous equation problem
6	5	81%	Quadratic Graph

PAPER 2

Order of popularity	Question number	Percentage attempted	Topics
1	1	100%	General
2	5	94%	Co-ordinate Geometry
3	2	91%	Ratio; Percentages; Mensuration
4	3	89%	Geometry
5	4	80%	Geometry
6	6	46%	Trigonometry

3.2 General Comments

The overall standard of answering was similar to that of 1998 and 1997. It is encouraging to note that the percentage of A grades awarded (7.7%) was higher than the percentage awarded in 1998 (6.2%). This increase in the number of candidates who have a very good command of the syllabus and who are able to communicate their knowledge and skills by presenting their work clearly and logically is welcomed.

However, there were many candidates who did not fare so well. In general, the work presented by candidates supported the view expressed in the Report on the 1998 Ordinary level examination that there are key areas in which efforts must be concentrated in order to improve overall standards. The most pressing message again this year was that candidates' progress in their answering of questions was hindered by poor arithmetical and algebraic skills. Algebra deserves particular mention in this regard. The long questions on algebra were both low scoring and unpopular choices. Furthermore, candidates often ignored parts of other questions which involved algebra.

Assistant examiners pointed to specific weaknesses which frequently came to their attention as being areas in which there were particular deficiencies. These are very similar to those detailed in the 1998 Report. However, a brief summary is as follows:

- carrying out arithmetical calculations with accuracy
- foundation skills in algebra such as transposition, using the distributive law, factorisation and expressing two fractions as one
- basic trigonometrical skills
- working with negative numbers.
- evaluating expressions
- manipulating fractions
- using verbal information to form simultaneous equations
- working with scientific notation particularly where negative indices are involved
- solving inequalities and graphing their solutions
- deriving information from a quadratic graph
- performing set operations especially set difference and complement.

Another area of concern deserving particular mention is trigonometry. There was no evidence to support the optimism expressed at Higher level that standards are improving in this branch of mathematics. Performance was poorer this year than that of 1998. Trigonometry was frequently unattempted. Moreover, when it was attempted, candidates' skills were often limited to looking up the values of the sin, tan and cos in the tables.

The importance of candidates learning to lay out their work clearly and methodically cannot be overemphasised. Candidates should be reminded that neither writing in pencil nor the use of correcting fluids is recommended. This year a sizeable number of candidates came to the second examination without the necessary geometrical instruments. As a result, they were unable to do construction work and to measure angles with the required degree of accuracy.

Finally, attention must be focused on the 749 candidates, that is 2.4% of the total who took the Ordinary level examination, who obtained grade F or less. Many of these young people would have been better suited to the Foundation level examination.

3.3 Overview of Questions

PAPER 1

The average mark on question 1 out of 100 was 55.5. Candidates performed well in parts (i), (ii) and (v). Attempts to simplify the straightforward fraction in part (iii) abounded with errors. Substitution and transformation difficulties were clearly evident in parts (iv), (vi), (vii) and (viii). Only high performing candidates could cope with the factorisation required in part (ix).

Out of 50, the average mark awarded for question 2 was 33.4. The structure of the compound interest problem was helpful to candidates. Generally, it was done well. In part (b), while most candidates got the curved surface area successfully, calculation of the total surface area caused problems. Many had no idea of how to approach this. It was often ignored.

Question 3, yielding an average mark of 24.3 out of 50, was the lowest scoring on the paper thus reflecting the extent of candidates' difficulties with algebra. Notwithstanding this, the parts involving the linear equation and the trinomial were well done. The factorisation involving grouping of terms suffered from sign errors. Very few candidates could derive the correct simultaneous equations although those who did usually solved them without difficulty.

Question 4 with an average mark of 37.7 was the most popular question. It was also the highest scoring. All parts were answered well although some candidates did not relate 'modal' with 'mode'. On occasions, there was confusion between the two separate means which the question required.

Unlike previous years, question 5 was the least popular question. It yielded an average mark of 32.9 out of 50. The graph was well drawn. Usually it was done on graph paper. This good practice was welcomed. The most common error was the non-uniform graduation of the axes. There was much difficulty in using the graph to answer parts (i) and (iii). Very few were able to construct the axis of symmetry.

The average mark for question 6 was 28.7 out of 50. Again, this reflected badly on the candidates' proficiency in algebraic skills. The standard time/speed problem was well done. Candidates were surprisingly unable to handle the sets question. Their performance suggested that perhaps the work on sets learnt in first year had not been recently revised. Part (c) presented extreme difficulties. It was only very rarely that candidates seemed familiar with the correct method. Even then, their working seldom led to the correct result.

PAPER 2

The average mark awarded for question 1 was 63.5 out of 100. Parts (i), (ii), (iii), (viii) and (ix) were generally well answered. It was, however, surprising that so many candidates did not know the number of minutes in a degree. The construction lines in part (iv) were often erased or left out. Many did not calculate the square root at the end of part (v). Parts (vi), (vii) and (x) were challenging.

Question 2, yielding an average mark of 37.0 out of 50, was the highest scoring. Ratio was handled well as was the calculation of areas. Candidates often lost marks as a result of not reading the question properly. For example, the percentage of students who walked was sometimes given instead of the number. Similarly, the amount of the area of the square remaining was presented instead of the percentage.

The average mark awarded in question 3 was 33.3 out of 50. Generally speaking, part (i) was not answered satisfactorily. It was often ignored. Furthermore, many of the attempts presented lacked precision. Some candidates were not aware that diagrams given on the examination paper are not to scale. Accordingly, they used measurements to answer (ii) and (iii). Again, as in question 1(viii), transformation geometry was handled well. Parts (v) and (vi) which required work over and above studying the diagram, proved challenging. They were well done only by the most able.

Question 4 yielded an average mark of 29.6 out of 50. Overall, it was well answered. However, candidates had difficulties naming angles clearly and correctly. As in the

previous question, parts (v) and (vi) which required a deeper level of thinking proved to be testing. The involvement of the square root posed extra problems.

The average mark in question 5 was 32.7 out of 50. It was the most popular but not the highest scoring. In general, candidates showed a good grounding in the basics of co-ordinate geometry. Errors with signs caused problems for many. Weaknesses were evident in finding where the line intersected the axis and in substituting into the equation of the line.

Performance in question 6 indicated that trigonometry was an area of great weakness. The average mark awarded was 17.1 out of 50. This, along with the fact that only 46% of candidates attempted the question, illustrates the need for attention to be focused in this area. Many efforts were feeble with candidates doing no more than looking up the tables for values of cos.

4. CONCLUSION

Performance in the examinations of 1999 was closely in line with that of the previous two years. The percentage taking Higher level continued to increase slightly, reaching 36% for the first time.

In general, girls outperformed boys with one notable exception. At Higher level, a greater percentage of boys were awarded grade A.

At both levels, there were large numbers of candidates who laid out their work neatly and clearly. This approach to presentation reflects good training. It is to be highly commended.

At Higher and Ordinary levels, candidates performed well in statistics and co-ordinate geometry. Ordinary level candidates showed good knowledge of transformation geometry but at Higher level axial symmetry was not well understood. Reflecting the difficulties which are becoming increasingly evident in synthetic geometry at Higher level, candidates did not respond well to the questions that called for proofs and applications of theorems.

Higher level candidates' improved performance in trigonometry was noted. Continued improvement should be encouraged. However, at Ordinary level, there were definite indications that standards in trigonometry are falling. Moreover, at this level the topic was very low in popularity. This is a cause for concern.

As a concluding comment, candidates' weaknesses were in areas similar to those highlighted in the Reports of 1996 and 1998. At both levels, significant numbers of candidates had inadequate command of foundation skills and knowledge and their overall performance suffered adversely as a result. Attention must be focused, in particular, on improving students' proficiency in algebra especially as basics of this area are essential for success in senior cycle mathematics.

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