Comisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION 2005

CHEMISTRY

CHIEF EXAMINER'S REPORT

HIGHER AND ORDINARY LEVELS

CONTENTS

1. INTRODUCTION

The present Leaving Certificate Syllabi for both Higher and Ordinary level Chemistry were examined for the first time in 2002. The structure and rubrics of both examination papers are the same. Eleven questions are present on the examination paper. All questions are valued at 50 marks. The examination paper is divided into two sections. Section A has three questions on mandatory practical work. Section B contains eight questions on a range of topics across the syllabi. The examination papers are marked out of a total of 400 marks. Candidates are expected to answer eight questions which must include at least two questions from Section A.

Participation Rates in Chemistry

The overall number of candidates taking the Leaving Certificate Chemistry examinations over the past eight years is summarised in Table 1.

Table 1 Overall participation rates in Leaving Certificate Chemistry

Year	Candidates taking Chemistry	Percentage of total number of Leaving Certificate candidates
1998	7325	11.4
1999	6962	11.1
2000	6711	11.3
2001	6355	11.6
2002	6495	12.0
2003	6698	12.1
2004	7227	12.9
2005	7366	13.6

The gradual decline in participation rates in Chemistry since the late 1980s has been the subject of much comment. At that time participation rates of the order of 20% were common. Participation reached a low of 11.1% in 1999. For the past six years there has been a steady increase in the participation rates in Chemistry and the present participation rate stands at 13.6%. Given that the participation rate was in decline for the previous 12 years or so this turnabout is most encouraging. The origin of this improvement in participation rates can be attributed to a combination of interventions. These interventions included a rebalancing of content and level of accessibility of the examination papers in 2000 in response to the results of research on examinations carried out by the Education Research Centre. Revised syllabi for Leaving Certificate Chemistry were introduced for examination in 2002 as part of the Physical Sciences Initiative. This initiative also incorporated a major in-service programme for teachers as well as enhanced resources for schools.

Table 2 Division of the Leaving Certificate Chemistry cohort between Ordinary and Higher levels

Year	Total no of Chemistry Candidates	Number of OL Candidates	Number of HL Candidates	Percentage OL Candidates	Percentage HL Candidates
1998	7325	1429	6645	17.7	82.3
1999	6962	1153	5809	16.6	83.4
2000	6711	1180	5531	17.6	82.4
2001	6355	1141	5214	18.0	82.0
2002	6495	932	5563	14.3	85.7
2003	6698	967	5731	14.4	85.6
2004	7227	1022	6205	14.1	85.9
2005	7366	1333	6033	18.1	81.9

In the years immediately prior to the introduction of the new syllabi the way in which the total Leaving Certificate Chemistry cohort split between Ordinary Level and Higher Level remained almost constant with between 16.6% and 18.0% taking the Ordinary Level paper each year. Interestingly, for each of the three initial examinations of the new syllabi the imbalance between the numbers taking Higher Level and Ordinary Level increased with participation rates at Ordinary Level dropping to around 14.3%. This year the trend changed with participation rates at Ordinary Level rising again to 18%. Whether this pattern is sustained remains to be seen in future year. The overall increase in numbers taking Chemistry is a very welcome trend but the relatively low numbers taking Ordinary Level paper remains a cause for concern.

Table 3 Gender breakdown of the Leaving Certificate Chemistry candidate cohort

Year	Number of Chemistry Candidates	Number of Females	Number of Males	Percentage Female	Percentage Male
2005	7366	4134	3232	56.1	43.9

A number of observations are made in relation to the gender breakdown of the Leaving Certificate cohort of candidates. Since the late 1980s, when the Intervention Project supported the introduction and promotion of both Physics and Chemistry in girls' schools and co-educational schools, the percentage participation rate of females in Chemistry has gradually increased. By 1996 48.3% of the Leaving Certificate Chemistry cohort was female and statistical equity in terms of participation rates

was reached in 1997 with 50.1% of the cohort being female. The pattern of gradually increasing participation rates for females has continued and in 2002 53.5% of the Leaving Certificate Chemistry cohort was female. The overall figure this year for female candidates stands at 56.1%. It is also interesting to note that when the gender breakdown across the Higher and Ordinary level examinations is analysed 84.4% of females took the Higher Level examination this year compared with 95.7% of female candidates three years ago. In the case of male candidates 78.7% of the male candidates took the Higher Level examination paper with 21.3% taking the Ordinary level. The division of male candidates between Higher and Ordinary level three years ago was 80 : 20. The statistics show that the overall increases in the numbers taking Chemistry is characterised by a steady increase towards female participating in the subject. There also appears to be a gradual equalisation of the differing participation rates observed in the past for males and females at Higher Level and at Ordinary Level.

2. PERFORMANCE OF CANDIDATES

2.1. Higher Level

The overall performance of candidates at Higher Level in recent years has remained good with a good standard being maintained. There is some anecdotal evidence that some candidates gamble in trying to predict the questions which are likely to appear in Section A in particular. The existence of this practice is supported by the lower popularity and the lower than expected average scores obtained by candidates on questions on recrystallisation, relative molecular mass determination and soap preparation over the past three years. Such practices can adversely affect a candidate's performance in an examination which has very limited choice and should be discouraged. Year-on-year variations in grade distribution is relatively small with an average return of A grades around 23% and a combined A+B+C grade return of around 77% in recent years.

Statistics on the distribution of grades for Higher Level candidates are presented in Tables 4 to 6.

Table 4 Distribution of grade by percentage in grade bands A to C, D, and E to NG for Higher Level candidates

Higher Level Chemistry			
Year	**Percentage A – C Grades**	**Percentage D Grades**	**Percentage E - NG Grades**
1998	69.9	20.1	9.9
1999	69.3	22.6	8.1
2000	72.7	19.3	7.9
2001	74.9	17.4	7.6
2002	77.1	16.0	6.9
2003	78.8	15.2	5.8
2004	76.0	16.3	7.8
2005	76.8	16.5	6.8

Table 5 Distribution of grade by percentage for Higher Level candidates

Higher Level Chemistry – Grades by percentage					
Year	**A**	**B**	**C**	**D**	**E, F & NG**
1998	15.7	28.3	25.9	20.1	9.9
1999	16.1	26.1	27.1	22.6	8.1
2000	20.0	27.6	25.1	19.3	7.9
2001	22.3	28.6	24.0	17.4	7.6
2002	23.0	29.7	24.4	16.0	6.9
2003	26.0	30.0	22.8	15.2	5.8
2004	23.0	30.1	22.9	16.3	7.8
2005	22.2	30.4	24.2	16.5	6.8

Table 6 Detailed distribution of sub-grades by percentage for Higher Level Candidates

Higher Level Chemistry – Sub-grades by percentage														
Year	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**NG**
1998	7.9	7.8	8.4	9.6	10.3	8.7	9.8	7.4	6.8	6.4	6.9	7.0	2.5	0.4
1999	8.5	7.6	7.9	8.4	9.8	8.2	9.6	9.3	7.0	7.1	8.5	6.0	1.8	0.3
2000	10.6	9.4	9.2	9.6	8.8	7.8	8.9	8.4	6.1	6.0	7.2	5.8	1.9	0.2
2001	12.7	9.6	9.7	10.6	8.3	8.3	8.1	7.6	5.8	5.4	6.2	5.5	1.7	0.4
2002	11.5	11.5	10.4	9.8	9.5	8.8	7.9	7.9	6.0	4.8	5.2	4.8	1.8	0.3
2003	15.1	10.9	10.2	10.0	9.8	7.8	7.8	7.2	5.2	4.9	5.1	4.2	1.2	0.4
2004	12.8	10.2	10.0	10.7	9.4	8.3	7.5	7.1	5.7	5.0	5.6	5.6	1.9	0.3
2005	11.4	10.8	10.9	9.9	9.6	9.2	7.4	7.6	5.4	5.6	5.5	4.8	1.6	0.4

In the period 1998 to 2002 the percentage of candidates receiving grades A to C at Higher Level increased from 69.9% to 77.1%. The percentage of candidates obtaining a Grade A increased from 15.7% to 23.0%. Over the same period the percentage of candidates receiving grades E, F or NG fell from 9.9% to 6.9%. The overall standard of knowledge of the subject, as illustrated by answers provided by Higher Level candidates in the examination papers, remains very good. It is particularly encouraging to see the high standard of answering and a similar distribution of high grades transfer from the previous syllabus to the revised course and the new examination and that this standard has been maintained over the early years of operation of the new course.

Table 7 Breakdown of sub-grades by gender for candidates at Higher Level

Higher Level Chemistry - Distribution of Sub-grade by gender												
Grade	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E, F & NG**
Total Chemistry (6033)	688	651	655	596	581	556	444	460	323	335	334	410
Percentages	11.4	10.8	10.9	9.9	9.6	9.2	7.4	7.6	5.4	5.6	5.5	6.8
Total Female (3489)	391	387	377	374	353	332	260	248	189	191	180	207
% Female	11.2	11.1	10.8	10.7	10.1	9.5	7.5	7.1	5.4	5.5	5.2	5.9
Total Male (2544)	297	264	278	222	228	224	184	212	134	144	154	203
% Male	11.7	10.4	10.9	8.7	9.0	8.8	7.2	8.3	5.3	5.7	6.1	8.0

As is evident from the table, female candidates outperform male candidates slightly with a higher A grade return of 22.3% (the overall A grade rate was 22.2% and the A grade rate for male candidates was 21.1%). Similarly, the percentage of female candidates receiving A, B and C grades was 78.0% with the overall figure being 75.0% and the A, B and C grade return from male candidates being 74.1%. At the other end of the spectrum the E, F and NG return for female candidates was 6.8% compared with an average of 8.0% of male candidates returning E, F or NG grades. This phenomenon is common in most subject areas and not significantly different from what has been observed for a number of years.

2.2 Ordinary Level

Detailed statistics on the distribution of grades for Ordinary Level candidates are presented in Tables 8 to 10.

Table 8 Distribution of grade by percentage in grade bands A to C, D, and E to NG for Ordinary Level candidates

Ordinary Level Chemistry			
Year	**Percentage A – C Grades**	**Percentage D Grades**	**Percentage E - NG Grades**
1998	46.5	31.7	21.5
1999	68.7	17.6	13.6
2000	78.6	14.5	6.8
2001	68.4	21.1	10.4
2002	55.7	26.3	17.9
2003	78.7	14.6	6.6
2004	70.1	20.9	9.0
2005	63.7	24.5	12.0

Table 9 Distribution of grade by percentage for Ordinary Level candidates

Ordinary Level Chemistry – Grades by percentage					
Year	**A**	**B**	**C**	**D**	**E, F & NG**
1998	2.2	15.1	29.2	31.7	21.5
1999	10.0	29.9	28.8	17.6	13.6
2000	13.9	35.5	29.2	14.5	6.8
2001	15.0	27.2	26.2	21.1	10.4
2002	4.7	20.6	30.4	26.3	17.9
2003	15.1	35.6	28.0	14.6	6.6
2004	9.2	29.7	31.2	20.9	9.0
2005	10.1	26.0	27.6	24.5	12.0

Table 10 Detailed distribution of sub-grades by percentage for Ordinary Level Candidates

Ordinary Level Chemistry – Sub-grades by percentage														
Year	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**NG**
1998	0.5	1.7	2.4	5.1	7.6	7.9	10.5	10.8	9.5	10.0	12.2	13.1	7.2	1.2
1999	3.1	6.9	5.7	10.3	13.9	7.1	11.1	10.6	4.9	6.2	6.5	6.9	5.1	1.6
2000	5.7	8.2	7.5	13.3	14.7	8.5	10.7	10.0	4.8	4.4	5.3	4.7	1.4	0.7
2001	5.3	9.7	6.7	10.0	10.5	7.4	9.5	9.3	5.7	6.9	8.5	6.3	3.6	0.5
2002	2.0	2.7	3.4	7.3	9.9	8.0	10.1	12.3	7.3	7.9	11.1	9.2	6.8	1.9
2003	5.9	9.2	10.8	12.4	12.4	9.7	9.8	8.5	6.7	3.7	4.2	5.1	1.4	0.1
2004	3.1	6.1	8.5	11.2	10.0	11.7	10.5	9.0	6.8	6.1	8.0	5.1	3.2	0.7
2005	4.0	6.1	7.7	8.6	9.7	9.7	9.1	8.8	8.9	8.3	7.3	7.8	3.7	0.5

The changes in the structure and layout of the Ordinary Level examination paper, which occurred in the 1999-2001 period, increased the accessibility of the examination to candidates and resulted in an improved distribution of grades for Ordinary Level candidates over that period. In particular the percentage of candidates receiving E, F and NG grades, which had been previously averaging at around 20%, decreased. There was also a significant increase in the percentage receiving A grades. There has been some fluctuation in the distribution of grades at Ordinary Level over the past few years. It is difficult to ascribe this to any single thing apart from making the observation that in some years a significant number of candidates opt for the Ordinary Level who would it seems, on the basis of the scripts they produce, have acquitted themselves respectably at Higher Level. In other years the cohort is noticeable by the absence of such candidates. With small cohorts such as that for Ordinary Level the addition of small numbers of stronger or weaker candidates can have a significant impact on the statistics.

Table 11 Distribution of sub-grades by gender at Ordinary level

Ordinary Level Chemistry - Distribution of Sub-grade by gender												
Grade	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E, F & NG**
Total Chemistry (1333)	53	81	102	115	129	121	117	118	111	97	103	167
Percentages	4.0	6.1	7.7	8.6	9.7	9.7	9.1	8.8	8.9	8.3	7.3	12.0
Total Female (645)	36	48	60	71	53	68	55	57	53	50	39	55
% Female	5.6	7.4	9.3	11.0	8.2	10.5	8.5	8.8	8.2	7.8	6.0	8.5
Total Male (688)	17	33	42	44	76	61	66	60	65	61	58	105
% Male	2.5	4.8	6.1	6.4	11.0	8.9	9.6	8.7	9.4	8.9	8.4	15.2

As is evident from the table, female candidates out perform male candidates with a higher A grade return of 13.0% (the overall A grade rate was 10.1% and the A grade rate for male candidates was 7.3%). Similarly, the percentage of female candidates receiving A, B and C grades was 69.3% with the overall figure being 63.7% and the A, B and C grade return from male candidates being 58.0%. At the other end of the spectrum the E, F and NG return for female candidates was 8.5% compared with an overall figure of 12.0% and 15.2% of male candidates returning E, F or NG grades. The pattern is similar to the observations made at Higher Level though slightly more pronounced. This phenomenon is common in most subject areas and the pattern is not significantly different from what has been observed for several years.

3 ANALYSIS OF CANDIDATE PERFORMANCE

3.1 Higher Level

The numbers of candidates receiving each grade and the percentage this represents of the total number of scripts is presented in Table 12.

Table 12 Percentages of candidates receiving each grade at Higher Level

Higher Level Chemistry –Percentages achieving each grade in 2005					
	A	**B**	**C**	**D**	**E, F & NG**
Percentage	22.2	30.4	24.4	16.5	6.8

The distribution of these grades has been discussed in an earlier part of this report.
Analysis of a selection of scripts taken at random provides some information on the popularity and marks obtained from the various questions offered in the examination paper.

Table 13 Statistical data on the answering of the Higher Level examination paper

Higher level Chemistry examination – analysis of questions*						
Section	**Question**	**Percentage of attempts**	**Rank order in terms of popularity**	**Average Mark with (%)**	**Rank order in terms of mark**	**Topic**
A	**1**	75	8	35.6(71.2)	5	Volumetric
	2	82	6	33.4(66.8)	7	Organic
	3	86	3	37.4(74.8)	3	Rates
B	**4**	90	2	32.8(65.6)	8	Short items
	5	83	5	36.2(72.4)	4	Atom
	6	85	4	35.5(69.0)	6	Organic
	7	80	7	37.6(75.2)	2	Organic
	8	93	1	38.4(76.8)	1	Acids/Water
	9	39	10	29.7(59.4)	10	Equilibria
	10	54	9	32.9(65.8)	9	General
	11	34	11	24.4(48.8)	11	General

***** These statistics have been drawn from an analysis of approximately 8% of scripts which were selected at random.

Question 8 on the paper was the most popular followed by question, 4, 3, 6 and 5 in that order. Question 8 which was on acids, bases pH and sewage treatment was also the best-answered question followed closely by questions 7, 3 and 5. An increase in popularity and indeed in the average mark awarded in the organic chemistry questions (questions 2, 6 and 7) was observed compared with that seen three years ago. Indeed, the quality of answering of the questions on organic chemistry recveived favourable comment from examiners. It suggests that the pattern of the past, where a significant number of candidates omitted organic chemistry, is being gradually broken. This is encouraging though, unfortunately, the same observation cannot be made at Ordinary Level. Questions 9, 10 and 11 were the least popular questions and were also least well answered. One of these three questions was regularly attempted as an extra question and had its score discarded.

It was also unusual to find a question as popular as question 4 ranking so lowly in terms of average mark awarded. A significant number of candidates failed to find eight items they could successfully attempt.

Other interesting statistics gained from analysis of these randomly selected scripts showed that the vast majority of candidates obeyed the instructions on the examination paper. Very few candidates (~1.8 %) attempted less than eight questions. Just over a half of all candidates attempted at least one extra question and nearly 60% of all candidates attempted all three questions from section A.

Whilst the overall standard of answering was good and, indeed, excellent by many candidates the comments offered here are aimed principally at highlighting some of the common errors made by candidates in answering the examination paper.

Question 1 [Volumetric analysis] Average mark 35.6 (71.2%) Response 75%

The fact that the measurement of dissolved oxygen has never appeared as a volumetric analysis practical question may go some way towards explaining why it was the least popular volumetric question since the first examination of the new syllabus in 2002. Answering of part (a) was generally poor with many candidates failing to explain why the oxygen level may change over time. The reason why concentrated solutions were required was not well understood and the need to exclude air-bubbles was often not stated in parts (b) and (c). All other parts of the question were answered well including the calculation in the final part.

Question 2 [Organic: ethanal] Average mark 33.4 (66.8%) Response 82%

This question ranked sixth in terms of popularity and seventh in terms of the average mark awarded. This was the least well answered of the three questions on organic chemistry. Not being able to offer a second suitable "feature of the preparation" in part (b) and omitting one or more of the mixing of Fehling's No 1 and No 2, heating or making the observation that a red precipitate was produced in part (d) were the most common sources of loss of marks. The calculation in part (e) was successfully carried out by the majority of candidates though some made errors. Apart from mathematical slips, failure to get 75% of the theoretical yield, not using the 1 : 3 mole ratio and the use of incorrect relative formula masses were the most common mistakes. Candidates should be encouraged to show all calculations (including how they arrive at molecular of formula masses). It is often here that mathematical slips are often made. Showing calculations can serve to minimise the penalties incurred when the script is marked if an incorrect answer results.

Question 3 [Rate of reaction] Average mark 37.4.0 (74.8%) Response 86%

The number of candidates making incorrect attempts at writing an equation for the decomposition of hydrogen peroxide in part (a) was surprising. Part (b) was reasonably well answered but some had difficulty in describing or arranging to have the reaction start at an exact time. Some also opted for the use of a dropping funnel to add the peroxide which is inappropriate. Parts (c), (d) and (e) were answered well. Part (f) was not answered well with many candidates answering without reference to the graph. Many of those who did refer to the graph only identified one change – that the curve would be less steep.

Question 4 [Short items] Average mark 32.8 (65.6%) Response 90%

This was the second most popular question on the paper and in comparison with previous years it was poorly answered. Apart from parts (a), (d) and (i), which were answered very well, different candidates experienced difficulty spread across most of the other items. Common incorrect shapes cited in part (b) were triangular, trigonal and tetrahedral. Names of other sets of lines of the hydrogen emission spectrum were given in answer to part (c). In part (e) most knew the definition of an orbital but correct descriptions of a sub-level were rare. Most knew the correct reagents for part (f) but did not describe how the addition of the conc. sulphuric acid should be made. Attempts at part (g) gave rise to all sorts of incorrect structures. Many candidates made no correct step in the right direction in attempting part (h) i.e. not even subtracting the mass of copper from the mass of the compound to get the mass of chlorine present. A common incorrect answer to part (j) was to give the formula C_2H_5Na as the organic product. Both items in part (k) were poorly answered by any candidates. In particular the attempts at the equations for the destruction of ozone were often characterised by radical species not identified by dots. When questions of this type were compulsory in the examination of the

previous syllabi they were usually the best answered question on the examination paper probably because they were practiced. Candidates would benefit from practicing questions of this type.

Question 5 [Atomic structure] Average mark 36.2 (72.4%) Response 83%

This question was popular (fifth in popularity) and answered to a better standard than other questions on atomic structure since the introduction of the new examination. In part (a) most explained the term "isotope" satisfactorily but occasional candidates confused the term with "isomers". Becquerel was widely known though the spelling of his name showed some variations. Curie and Rutherford were the most common incorrect answers. Most identified a radioactive isotope but in many instances failed to match this with a correct use. In part (b) definitions of atomic radius often lacked some vital point. The trends were generally well described and explained. Where marks were lost it usually related to misunderstandings or omissions relating to screening effects of electrons in inner shells. In part (c) definitions of a covalent bond were good. Where marks were lost in distinguishing between sigma and pi bonding candidates usually either did not use the term "orbitals" when describing sigma bonding or did not refer to "p orbitals" when describing pi bonding.

Question 6 [Organic] Average mark 34.5 (69.0%) Response 85%

This question ranked fourth in terms of popularity and sixth in terms of average mark awarded. The response rate and quality of answering of this question was very similar to that seen for comparable questions (on fuels/thermochemistry) in recent years. In general parts (a) (i), (ii), (iii) and (iv) were well answered. Some candidates gave answers in terms to health and environmental issues for (iii) or mentioned benzene or catalytic cracking or isomerisation for (iv). Attempts to part (b) showed evidence of widespread misunderstanding of what is meant by "straight chain". Many candidates seem to think that simply bending the end of a carbon-chain produces a new isomer. This resulted in candidates generating lots of identical structures. Part (c) was answered well though many candidates omitted to divide by 2 to get the heat change for 1 mole.

Question 7 [Organic] Average mark 37.6 (75.2%) Response 80%

Though ranking only seventh in term of popularity this question ranked second in terms of average mark awarded. This was the most popular and best answered question on organic theory since the present examination format was put in place. Parts (a), (b) and (c) were well answered. A small number of candidates incorrectly used the term "clear" instead of "colourless". This is an error that has been seen before and it appears that the difference between the terms "clear" and "colourless" is not obvious to some candidates. Part (d) was not well answered. Many could only describe one or two pieces of evidence and others simply described the mechanism.

Question 8 [Acids-bases/water] Average mark 38.4 (76.8%) Response 93%

This was the most popular question on the examination paper and the best-answered question. Interestingly, it was much more popular and better answered than corresponding questions in previous years. Parts (a), (b) and (c) were well answered. In part (d) most candidates knew the BOD conditions some gave 25 ºC as the temperature. In many cases very long answers were given to part (e). These usually had the required information. Some candidates, however, described the treatment of drinking water at length rather than sewage treatment.

Question 9 [Equilibrium] Average mark 29.7 (59.4%) Response 39%

This question was the least popular on the examination paper and the average mark returned by candidates was the second lowest of all the questions. For many candidates it was a disallowed extra question. Part (a) was well answered. However, part (b) was very poorly answered. Candidates did not respond well to being offered a list of chemicals to choose which were required to set up a demonstration experiment that is one of the mandatory practical exercises on the syllabus. Part (c) was well answered though a few candidates still omit to use square brackets. The calculation was well attempted. Very few spotted the "perfect square" that would have made the calculation easier. Unfortunately, some candidates carried out the whole calculation in grams.

Question 10 [Two parts from three] Average mark 32.9 (65.8%) Response 54%

This was an unpopular question and it was not answered very well. This question was not very popular last year either and was answered even more poorly on that occasion. Part (c) was most popular but part (b) and (c) were also popular. Very few candidates attempted all three parts.

(a) [Stiochiometry]

In part (i) quite a few candidates did the calculation for just one tablet. A number tried to use the formula used in volumetric analysis for getting the volume of HCl. Parts (ii) and (iii) were answered well. In part (iv) many candidates knew the meaning of 6% (w/v) but could go no further. It is possible that because candidates encounter stiochiometry early in the course that by the time the examination comes around they have become less proficient at the calculations. Many of the attempts at this question and also question 4, part (h) suggest that more practice close to the examination date would be helpful.

(b) [Ionisation energy]

In part (i) virtually all candidates answered "ionisation energy" but the omission of "first" was common. Most stated the units as kilojoules per mole but some just stated kilojoules. Most candidates could write an equation for a first ionisation in part (ii) but few gave the state symbol for gases. In part (iii) most knew that less energy was required to ionise an excited atom but some could not explain why. Most answered part (iv) well.

(c) [Chromatography]

In stating the principle in part (i) most mentioned the stationary and mobile phases but many omitted to mention the idea of selective adsorption. The experiment was, in general, well described. The most common omission was not mentioning the movement of the eluent (solvent).

Question 11 [Two parts from three] Average mark 24.4 (48.8%) Response 34%

This was the least popular and least well-answered question. The response rate was down on previous years. Parts (a) and (b) were most popular. Where part (c) was attempted far more candidates attempted Option B.

(a) [Redox/Electrochemistry]

Part (i) was surprisingly poorly answered. Many candidates defined oxidation in terms of electron transfer. In part (ii) both the observations and the explanations were poorly answered. Few candidates knew the colour change. The response of candidates raises the question as to whether candidates ever did or saw this experiment. In part (iii) the majority of candidates chose the wrong electrode. Of the candidates who chose the correct electrode few were able to provide the required half-equation.

(b) [Gases]

Part (i) was well answered by most candidates. Quite a number of candidates confused Avogadro's law with Gay Lussac's law of combining volumes in part (ii). Most candidates knew the meaning of 10% (v/v) but many could not use this to arrive at 1 litre of helium gas. Disturbingly, there were a few candidates who seem to think that helium is diatomic.

(c) [Options]

A Option 1

This was by far the less popular of the two options. However, it was fairly well answered by the few who attempted it. In part (i) most knew one of the required points. In Part (ii) Roy Plunkett was not widely recognised as the discoverer of PTFE. Most candidates knew two of the three points required and in part (iv) the majority could give only one common use for PTFE.

B Option 2

This was the more popular of this unpopular part of question 11. In part (i) many mentioned the triple bond but did not develop the answer further. Some incorrectly linked the stability of the molecule with the stability of the nitrogen atom and its half-filled p-sublevel. In part (ii) the meaning of nitrogen fixation was well known though some candidates omitted to mention the atmosphere. Virtually all candidates could identify two methods of nitrogen fixation in nature. Part (iii) was poorly answered with most candidates not identifying the origin of the energy needed for nitrogen and oxygen to combine in the combustion engine. Equations were regularly omitted and often incorrect when an attempt was made.

3.2 Ordinary Level

The numbers of candidates receiving each grade and the percentage this represents of the total number of scripts is presented in Table 14.

Table 14 Percentages of candidates receiving each grade at Ordinary Level

Ordinary Level Chemistry – Numbers and percentages achieving each grade in 2002					
	A	**B**	**C**	**D**	**E, F & NG**
Percentage	10.1	26.0	27.6	24.3	12.0

The distribution of these grades has been discussed in an earlier part of this report.

Table 15 Statistical data on the answering of the Ordinary Level examination paper

Ordinary Level Chemistry examination – analysis of questions*						
Section	**Question**	**Percentage of attempts**	**Rank order in terms of popularity**	**Average Mark with (%)**	**Rank order in terms of mark**	**Topic**
A	**1**	66	7	21.3(42.6)	11	Organic
	2	93	3	34.5(69.0)	2	Volumetric
	3	83	6	35.0(70.0)	1	Rates
B	**4**	86	5	27.1(54.2)	7	Short items
	5	97	2	29.2(58.4)	6	Atom
	6	66	9	27.0(54.0)	8	Organic
	7	77	7	23.1(46.2)	10	Bonding
	8	58	11	32.3(64.6)	4	Organic
	9	99	1	34.5(69.0)	2	Water
	10	88	4	29.3(58.6)	5	General
	11	61	10	26.6(53.2)	9	General

***** These statistics have been drawn from an analysis of approximately 7% of scripts which were selected at random.

Question 9 on the paper was the most popular followed by question 5 and question 3. All of the questions were reasonably popular with only question 8 falling below an attempt rate of 60%. It is

interesting to note that questions 3, 6, 8 and 11 were the least popular questions on the examination paper. The observation is made that three of these were on organic chemistry and the fourth included half a question on the course options. This reinforces the view that a significant proportion of Ordinary Level candidates place little emphasis on organic chemistry and possibly omit the options altogether. The low level of uptake of questions on organic chemistry which forms a substantial part of the course is of concern. All three questions in Section A were fairly traditional in nature on the topics of preparative organic chemistry, volumetric analysis and rates of reaction. Question 4, which contained items similar to those seen in previous years, was ranked amongst the most popular questions (78% attempt rate). The quality of answering of this question was only average compared to the rest of the examination paper. It is interesting to note that when a similar question (question 1) in the examination papers for the previous syllabus was compulsory it was regularly the best-answered question on the examination paper. It appears that now that the question is no longer compulsory the level of practice and dedication to learning definitions amongst candidates has diminished. Questions 5, which was based on the history of atomic structure, the elements and radioactivity, was very popular but only ranked in the mid-range in terms of marks awarded. The relatively poor average mark was generally attributed to guessing on the part of some candidates. Question 9 which related to water and sewage treatment was both popular and well answered. Question 11 was the least popular on the examination paper and ranked amongst the lowest in terms of average mark awarded. The low attempt rate of question 11 (c) Option B suggests that this option has little uptake in schools.

Few candidates attempted less than eight questions with many answering at least one extra question. However, the attempt made at the disregarded question often yielded few marks. It was also noticeable that many candidates performed poorly (receiving less than 20 marks, 40%) on one or more of the questions included in their total mark. An analysis of the scripts awarded grades across the D1-C3 range showed that a significant proportion of these candidates included one or more questions for which they received less than 20 marks (40%) as a contributor to their final result. This suggests that whilst many of these candidates know parts of the course reasonably well their overall mark was affected adversely by a lack of knowledge across the course.

The overall standard of answering at Ordinary Level tends to be somewhat variable from year to year. This may be a feature of the relatively small cohort size (<3% of the total Leaving Certificate cohort). Unfortunately, this year was characterised by a significant increase in the number of candidates not achieving a grade D or higher in the examination. Many of these candidates fell well short of achieving a grade D.

Question 1 [Ethanal] Average mark 21.3 (42.6) Response 66%

This question was the least popular of the three practical questions and the least well answered question on the examination paper. A number of candidates attempted this question as an extra question or as one of their last choices. Part (a) was best answered. After that the responses of candidates suggested that much guess work was involved. The poor overall answering of this question raises the question as to whether a significant number of candidates had carried out or seen this experimental procedure.

Question 2 [Volumetric analysis] Average mark 33.5 (69%) Response 93%

This question was the third most popular and the second best answered on the paper. It was a traditional volumetric analysis question. Even candidates who otherwise performed poorly recognised the equipment and knew how to prepare and use these pieces of equipment. A significant number of candidates could not name a suitable indicator or give the colour change observed [part (c)]. This observation was also made in 2002. The calculation was avoided or poorly answered by many candidates [part (d)]. The extension of the experiment to produce a sample of sodium chloride was also poorly answered [part (e)].

Question 3 [Rate of reaction] Average mark 35.5 (70.0%) Response 83%

Though only ranking sixth in order of popularity this question was still a popular question with 83% of candidates attempting it. It was the best-answered question on the examination paper. The quality of graph drawing and the interpretation of the graph were excellent. Disappointing diagrams [part (b)] and a difficulty in explaining the slowing down of the reaction [part (d)] were the main areas where marks were lost.

Question 4 [Short items] Average mark 27.1 (54.2%) Response 86%

Fifth in terms of popularity and seventh in terms of average mark awarded the standard of answering of this short item type question has declined with it becoming non-compulsory when the examination structure was changed with the introduction of the revised syllabi were changed a few years ago. Part (b), which was a standard definition, was poorly answered. There has been a pattern in recent years where candidates show a low ability to display a familiarity with standard definitions and statements of laws. Some candidates gave a property (e.g. penetrating power) in place of the “nature (composition) of alpha-particles”. Whether they simply didn’t know the composition of α-particles or didn’t understand the phrase “nature (composition)” is unclear. Parts (a), (g), (j) and (k) were best answered.

Question 5 [Elements] Average mark 29.2 (58.4%) Response 97%

This was the second most popular question on the examination paper question but only ranking sixth in terms of average mark awarded. The fact that the question involved matching scientists with particular discoveries/theories seems to have contributed to its popularity. Those who knew the historical side of chemistry scored well but a number resorted to guessing and scored very poorly. Consequently, the average mark awarded was lower than might have been expected.

Question 6 [Alkynes] Average mark 27.0 (54.0%) Response 66%

The ninth most popular question on the examination paper figured marginally better (8^{th}) in terms of average mark awarded. Some candidates struggled with part (a) but most scored well on part (b). The familiarity of candidates with the preparation and testing of ethyne gas was in stark contrast to the lack of familiarity with the preparation of ethanal displayed in answers to question 1. In general, questions on organic chemistry are either well answered or poorly answered with few candidates occupying a middle ground. A significant number of candidates still neglect this area of chemistry in their studies.

Question 7 [Bonding] Average mark 23.1 (46.2%) Response 77%

This was the seventh most popular question on the examination paper. It was a very straightforward question on bonding and related material and was surprisingly poorly answered. The definitions of ionic and covalent bonding were poorly answered and the quality of dot and cross diagrams was also very poor. The colour that sodium chloride imparts to a Bunsen flame was generally known as was the fact that a stream of water is deflected by a charged rod. Few made the connection between the latter point and the polarity of water.

Question 8 [Organic] Average mark 32.3 (64.6%) Response 58%

This question was the least popular but it elicited some very good quality answers ranking fourth in terms of average mark awarded. The level of popularity and level of return in terms of marks for this question is consistent with the assertion that those who care to study organic chemistry can get reward in the examination but that many Ordinary Level candidates in particular choose to avoid the area altogether. Parts (a), (b), and (c) were reasonably well answered and attempts at drawing the apparatus in part (d) were generally good. A lot of guessing occurred in answers to part (e).

Question 9 [Water] Average mark 34.5 (69.0%) Response 99%

This was the most popular question on the paper with almost all candidates attempting it. It ranked second in terms of average mark awarded. Most of the marks were lost in part (b) with many candidates showing a poor knowledge of tertiary treatment.

Question 10 [Two parts from three] Average mark 29.3 (58.6%) Response 88%

This was a popular and reasonably well-answered question. Parts (a) and (b) were most popular. Part (c) was not popular and when attempted answers were very poor.

(a) [Fuels]

This part was reasonably well answered though perhaps not as well as might have been expected.

(b) [pH]

This part offered surprises on two fronts. On the positive side the calculation was reasonably well answered but on a negative side the number of candidates who offered a Junior Certificate level answer to the definition of pH was disappointing.

(c) [Free chlorine]

This part of the question was unpopular and poorly answered by most who attempted it. Those who attempted the question tended towards the comparator method but struggled to score marks. Little knowledge of the principles upon which the technique is based was shown.

Question 11 [Two parts from three] Average mark 26.6(53.2%) Response 61%

This was the second least popular question on the examination paper and was also amongst the poorer answered – ranking ninth in terms of mark awarded. Part (a) was the most popular and significantly better answered that either of the other two parts. Part (b) was unpopular, poorly answered with evidence of guessing. Where part (c) was attempted candidates tended towards sub-part **A** and answered to a reasonable standard. Sub-part **B** was unpopular.

(a) [Chromatography]

The more popular and better answered part of the question. Most made a reasonable attempt at describing the experiment. Not many could identify a valid use for tlc in forensic science.

(b) [Electrolysis]

Not popular, poorly answered and showed evidence of guessing.

(c) [Options]

A Option 1

By far the more popular of the two options and fairly well answered. Most marks were lost due to incomplete or partially accurate answers to parts (iii) and (iv).

B Option 2

Not popular. Few succeeded in identifying Davy. Definition of corrosion and description of the galvanising process was answered poorly. Most marks were acquired for suggesting how galvanising protects iron and naming an alternate method.

4. CONCLUSIONS

4.1 Higher Level

The Higher Level examination paper was well received by candidates, teachers and examiners and also by teacher representative organisations. It was considered a fair test of candidates' ability in Chemistry. The emphasis given to practical chemistry and social and applied aspects of the subject was seen as positive feature of recent examination papers.

In general, candidates followed the instructions on the examination paper correctly and attempted to answer the question that was being asked. In the vast majority of cases the manner in which candidates presented material was satisfactory. The observation that many of those candidates who receive E, F and NG grades fall well short on the knowledge, detail and accuracy required to reach a grade D remains a cause for serious concern. Many of these candidates would be better advised to attempt the Ordinary Level examination, which is significantly less demanding.

Knowledge of definitions was generally good, though candidates occasionally reword definitions without fully appreciating that accuracy was being lost in the process. In such instances marks are often lost needlessly. The number of mathematical problems has decreased in recent years. Some candidates (often those who ultimately receive lower grades) shy away from those parts of questions containing problems. The application of "consequential marking" in recent years has removed the problem of candidates who make an error early in answering a mathematical problem losing large quantities of marks. Consequently, damage is now more limited than before and this has almost certainly contributed to the overall improvement in the grade distribution yielded in recent years.

Many candidates attempted one or more "extra" questions suggesting that the examination paper does not present a problem *vis-à-vis* time. Many candidates attempted all three questions in Section A. This suggests that many candidates devoted time to the mandatory practical elements of the syllabus. However, there is some evidence of the possible omission or at least the placing of a low priority on some of the mandatory practical work (presumably because there was an unfounded expectation that they would not appear on the examination paper). Attempts at the earlier parts of the question on dissolved oxygen measurement (question 1) and the practical portion of the question on equilibria (question 9) suggested that some candidates had either never carried out these experiments or at least placed little emphasis on them.

Though the overall quality of answering was good and comparable to previous years answering, a number of areas have been identified as noteworthy of comment and in need of some attention:

- Probably the single most important piece of advice for teachers and candidates would be to stress the importance of accuracy. Chemistry is a rigorous science and demands accuracy of language. Nowhere is this clearer than in the statement of laws and definitions. Every year marks are lost needlessly by candidates by offering loose statements of laws and versions of definitions.
- Candidates should be encouraged to practise short answer type questions. The decrease in the performance of candidates in this type of question in recent years (cf. question 4) compared to the past, when such questions were compulsory, points specifically to a lack of practice as the overall decrease in the choice level within the examination paper probably ensures a greater level at course coverage than before.
- Given the guarantee of three mandatory experiments in Section A and the likely reference to others within the remainder of the examination paper candidates should cover this mandatory experimental material comprehensively.
- Candidates displayed weakness in attempting stiochiometry related questions [cf. questions 4 (h), 10 (a) and 11 (b)]. It is possible that because they tend to encounter this material early on in Fifth Year that they have become somewhat out of touch with it by the time they get to the examination.
- Though the description and explanation of trends in the periodic table asked in question 5 was generally answered well, the difficulty encountered by candidates in distinguishing orbitals from sublevels [question 4 (e)] suggests that the problem observed in the past of confusion amongst candidates between the descriptors such as shell, orbit, energy level, main energy level, sub-shell, sub-level, orbital and their ability to use them almost randomly at times remains.
- Good knowledge of reaction mechanisms has been displayed in the past. The question this year on supporting evidence was not answered as well and, perhaps, requires more emphasis.

4.2 Ordinary Level

The Ordinary Level examination paper was well received by candidates, teachers and examiners and also by teacher representative organisations. It was considered a fair test of candidates' ability in Chemistry. Attention was drawn to the amount of text present on the examination paper. This, however, reflects the need for candidates at this level to have highly structured questions and their proven inability to answer less structured questions with the required level of detail. The play-off between having more diagrams and the knock-on effect of this requiring the examination paper to run to further pages is also a conflict that arises. The emphasis given to practical chemistry and social and applied aspects of the subject was seen as positive.

In general, candidates followed the instructions on the examination paper correctly and attempted to answer the question that was being asked. In the vast majority of cases the manner in which candidates presented material was satisfactory. However, the standard of answering was disappointing in some cases and the observation that many of those candidates who receive E, F and NG grades fall well short on the knowledge, detail and accuracy required to reach a grade D remains a cause for serious concern. In that context it is difficult to see what can be done in terms of the examination to reduce the percentage of candidates achieving less than a grade D.

Knowledge of definitions was often poor. The number of mathematical problems has decreased in recent years. Some candidates shy away from those parts of questions containing problems. The application of "consequential marking" has removed the problem of candidates who make an error early in answering a mathematical problem losing large quantities of marks.

Many candidates attempted one or more "extra" questions suggesting that the examination paper does not present a problem vis-à-vis time. Many candidates attempted all three questions in Section A. Unfortunately, some of the attempts at the question based on the preparation of ethanal showed little evidence for having ever carried out the experiment.

A number of general concerns are raised. These include:

- Candidates showing a lack of knowledge of simple definitions
- Candidates not being able to name a suitable indicator in question 2 or describe the colour change at the end-point
- Candidates showing poor performance on the short questions
- Candidates showing a tendency to avoid organic chemistry – given that there were two and a half to three questions on this area on the examination paper this practice severely restricts choice on the examination paper
- The combination of reduced choice and candidates having to answer eight questions requires good course coverage by the candidate.

5. RECOMMENDATIONS

5.1 Higher Level

Particular topics identified in the report as ones where candidates showed consistent difficulties were:

- Comprehensive coverage of mandatory experiments
- Accuracy in definitions and statements of laws
- Stiochiometry problems
- Short answer type questions
- Evidence supporting reaction mechanisms

Candidates and teachers are reminded that whilst a good level of syllabus coverage has been provided over the past four examinations there are still some areas of syllabus content to be examined for the first time. Consequently, the syllabus is the best guide to course content and reliance on the past four examination papers as an absolute guide to the examination would be unwise.

5.2 Ordinary Level

Particular topics identified in the report as ones where candidates showed consistent difficulties were:

- Knowing simple definitions
- Volumetric analysis
- Organic chemistry including the mandatory experiments
- Short answer type questions

The specific comments made in relation to these topics within this report should be used as a guide to future candidates so that they do not repeat these errors. In relation to organic chemistry one mandatory experiment and at least one and a half other questions appear on the examination paper. It is therefore unwise for candidates to omit this portion of the syllabus.

Ordinary Level candidates often do less work out of school than may be desirable. Consequently, the use of suitable reinforcement and revision material by Ordinary Level candidates may be worthwhile during those times when Higher Level candidates are engaged with material which is Higher Level only.

Past examination papers, the sample papers and supplementary questions which were issued prior to the first examination in 2002 as well as the examination papers for the last two examinations of the previous syllabus should be used as practice and as a guide to question lay-out and content.