LEAVING CERTIFICATE EXAMINATION

2002

PHYSICS

HIGHER AND ORDINARY LEVELS

CHIEF EXAMINER'S REPORT

1. INTRODUCTION

The revised syllabus for Leaving Certificate Physics was introduced into schools in 2000 and examined for the first time in 2002.

Physics at both Higher and Ordinary levels is assessed by means of a terminal written examination of three hours duration, marked out of 400 marks.

The paper is divided into two sections – A and B.

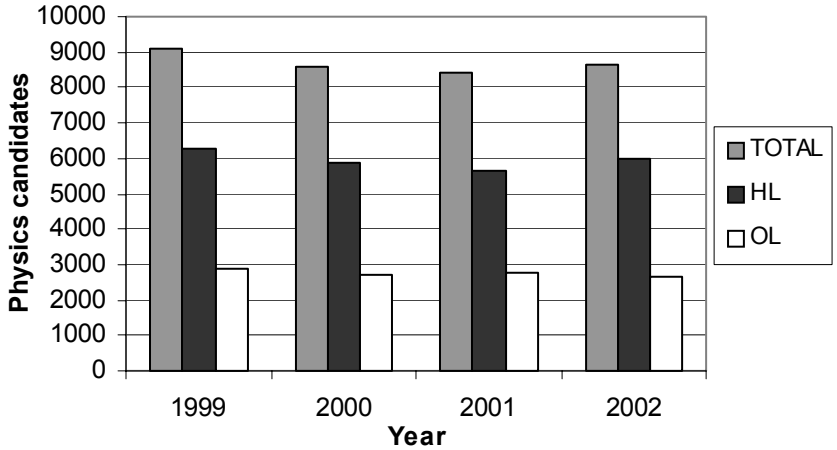
- Section A (30%) assesses the experiments listed in the syllabus that are required to be completed by the candidates during their course of study – three questions are to be answered from four given questions (40 marks each).
- Section B (70%) assesses the general syllabus content, including practical work – five questions are to be answered from eight given questions (56 marks each).
- Question 5 consists of ten short items, of which eight items are to be answered.
- Question 12 consists of four parts, of which two parts are to be answered.
- At Higher level in 2002, Question 10 examined the two options in the syllabus – Applied Electricity and Particle Physics. There are no options at Ordinary Level.
- There is no compulsory question on either examination paper.
- Appropriate data are provided in the relevant questions on the Higher Level paper.
- Appropriate formulae and data are provided in the relevant questions on the Ordinary Level paper.

Table 1 shows the number of candidates sitting Leaving Certificate Physics for the last four years. The data are illustrated in Fig. 1. The data show a reversal in the downward trend that has been evident for a number of years.

Table 1: Numbers of Leaving Certificate Physics candidates 1999-2002

				Higher level		Ordinary level	
Year	**LC candidates**	**% taking Physics**	**Physics candidates**	**Candidates**	**%**	**Candidates**	**%**
1999	62826	14.5%	9112	6257	68.7	2855	31.3
2000	60736	14.1%	8588	5849	68.1	2739	31.9
2001	56686	14.8%	8411	5643	67.1	2768	32.9
2002	55432	15.6%	8650	5986	69.2	2664	30.8

Fig. 1: Numbers of Leaving Certificate Physics candidates 1999-2002



2. PERFORMANCE OF CANDIDATES

Tables 2 and 3 show the numbers and percentages of candidates achieving each grade in the 2002 Higher level and Ordinary Level Physics examinations. The appendix shows a more detailed analysis of the data.

Table 2: Numbers of candidates achieving each grade in Higher Level Physics in 2002

Grade	A	B	C	D	E	F	NG	Total
Numbers	814	1526	1700	1322	424	178	22	5986
% of candidates	13.6%	25.5%	28.4%	22.1%	7.1%	3.0%	0.4%	

Table 3: Numbers of candidates achieving each grade in Ordinary Level Physics in 2002

Grade	A	B	C	D	E	F	NG	Total
Numbers	356	822	683	456	152	147	48	2664
% of candidates	13.4%	30.7%	25.6%	17.1%	5.7%	5.5%	1.8%	

Tables 4 and 5 show the average mark per question and the response rate in individual questions. The response rate is given as the percentage of candidates attempting each question in each section. Data in Table 4 are based on a random sample of 640 scripts, approximately 11% of the total Higher Level cohort. Data in Table 5 are based on a random sample of 334 scripts, approximately 13% of the total Ordinary Level cohort.

Table 4: Performance of candidates and response rates in Higher Level Physics 2002

Section	Question	Topic	Average mark(%)	Rank order	Response rate(%)	Rank order
A	**1**	Principle of moments	57	4	66	3
	2	Specific latent heat	62	3	90	2
	3	Stretched string	70	1	92	1
	4	*I-V* for $CuSO_4$	67	2	56	4
B	**5**	General	61	3	90	2
	6	Hooke's Law	46	7	69	3
	7	Wave motion	44	8	50	6
	8	Power transmission	58	5	67	4
	9	X-rays and PE effect	63	2	49	7
	***10 (a)**	Cockroft & Walton	75	1	38	8
	***10 (b)**	Semiconductors	30	9	14	9
	11	Lightning	47	6	63	5
	12	General	60	4	95	1

* Question 10 had an internal choice between (a) and (b).

Table 5: Performance of candidates and response rates in Ordinary Level Physics 2002

Section	Question	Topic	Average mark(%)	Rank order	Response rate(%)	Rank order
A	**1**	Measure *g*	57	4	70	3
	2	Stretched string	70	1	83	1
	3	Concave mirror	65	3	78	2
	4	Thermistor	67	2	54	4
B	**5**	General	60	2	93	1
	6	Forces	61	1	85	2
	7	Wave motion	38	8	51	5
	8	Current electricity	40	7	42	7
	9	Electromagnetism	50	5	29	8
	10	Cathode ray tube	47	6	43	6
	11	Radiation	50	4	63	4
	12	General	56	3	82	3

Comments

- In Section A of the Higher Level paper, 1% of the candidates failed to attempt the required three questions, while 9% of the candidates attempted all four questions.
- In Section B of the Higher Level paper, 5% of the candidates did not attempt the required five questions while 36% of candidates attempted more than five questions.
- 19% of the Ordinary Level candidates attempted more than the required number of questions.
- 40% of Ordinary Level candidates who were awarded grade E did not attempt the required number of questions.
- 84% of Ordinary Level candidates who were awarded grade F did not attempt the required number of questions.
- 96% of Ordinary Level candidates who were awarded NG did not attempt the required number of questions and most of these candidates wrote very little.

3. ANALYSIS OF CANDIDATE PERFORMANCE

HIGHER LEVEL

Section A

This section of the examination paper was well answered. Questions 3 and 4, which involved drawing graphs, were the best answered, although Question 4 was the least popular of the four questions in this section.

Question 1 **Average mark 57%** **Response rate 66%**

This question was fairly well answered but many candidates had difficulty explaining why the spring balances should be vertical.

Common errors included: taking the moments about the 50 cm mark; ignoring the weight of the metre stick; omitting the moment due to the weight of the metre stick; and confusion between clockwise and anticlockwise.

Question 2 **Average mark 62%** **Response rate 90%**

While this was a very popular question, it was not as well answered as either Question 3 or 4.

The first part of the question about the room temperature being halfway between the initial and final temperatures caused problems for candidates, with many referring to 'temperature' rather than 'heat' or 'energy' in their answers.

Many candidates failed to give a valid second reason for the discrepancy between their calculated value for the specific latent heat of fusion and the accepted value. Many candidates gave 'dry the ice' as an incorrect reason.

Question 3 **Average mark 70%** **Response rate 92%**

This was the most popular and best-answered question in section A.

The experiment was well described, often with a very good diagram. Many candidates used a newtonmeter to measure the tension but some candidates showed it at an angle to the wire.

Some candidates failed to state that the values for frequency and tension should be recorded/noted.

Question 4 **Average mark 67%** **Response rate 56%**

This was not a very popular question but it was well answered.

The most common mistake on the diagram was having the voltmeter in series or, in a few cases, in parallel with the rheostat.

A significant number of candidates failed to invert the slope to get the value of the resistance.

Section B

Questions 5 and 12, with internal choices, were the two most popular questions in this section. Five percent of the candidates failed to attempt the required five questions. Thirty-six percent of the candidates attempted at least one extra question. Generally those who failed to attempt the required five questions gave short answers to other questions.

Question 5 **Average mark 61%** **Response rate 90%**

This was the second most popular question in section B and it was reasonably well answered. Candidates were not as accurate in giving definitions as in former years. Parts *(c)*, *(f)*, *(g)* and *(i)* were well answered.

(a) Most calculated the value of the angular velocity correctly. Candidates produced a variety of incorrect units.

(b) More candidates gave a definition in terms of thermometric properties than gave a correct definition in terms of Kelvin temperature as specified in the revised syllabus.

(d) This part was well answered, with many candidates correctly explaining the effect with the aid of a diagram and/or a formula.

(e) This part was poorly answered, with many candidates omitting any reference to 'rate'.

(h) Most candidates made some reference to safety and many gave a correct answer.

(j) Many candidates referred to 'atoms' instead of 'nuclei'.

Question 6 **Average mark 46%** **Response rate 69%**

The name and formula for Hooke's law were known. Many candidates were confused between the 60 kg and 80 kg masses. The calculations were challenging for most candidates.

Many candidates used the formula for the simple pendulum instead of that for the spring.

Question 7 **Average mark 44%** **Response rate 50%**

Candidates explained constructive interference reasonably well. Explanations for 'coherent' were usually vague, with the need for the waves to be of the same frequency being often omitted.

In giving the condition for destructive interference most candidates referred to crests and troughs.

The experiments used by the candidates to demonstrate the wave nature of light were varied but well described.

The calculations were challenging for all but the most able candidates.

Question 8 **Average mark 58%** **Response rate 67%**

The definitions were often given in terms of the formula with an explanation of the symbols.

The experiment to show the heating effect often gave rise to very long responses, with some giving an account of an experiment to verify Joule's law. Most candidates achieved high marks in this part.

Parts (i) and (iii) of the calculations were often well attempted, while in part (ii) many candidates failed to use the correct formula, $P = RI^2$, to calculate the value of the current flowing in the cables.

Question 9 **Average mark 63%** **Response rate 49%**

This was not a very popular question but was well answered by those who attempted it. Candidates drew a good diagram of an X-ray tube but many omitted one or more of the following: cooling of the anode; vacuum in the tube; a window.

Candidates described well the experiment to demonstrate the photoelectric effect, with an even split between numbers using a zinc plate and those using a photocell.

Many candidates were successful in gaining marks for Einstein's explanation of the photoelectric effect by giving the correct formula and elaborating on it.

Question 10

This question contained an option – candidates did either *(a)* Particle Physics or *(b)* Applied Electricity. Nearly three times as many candidates opted for *(a)* as opted for *(b)*.

(a) **Average mark 75%** **Response rate 38%**

This question had the highest average mark of all questions on the paper. Candidates who answered this option had a good knowledge of the material and used the opportunity given by the question to display that knowledge. All parts were equally well answered, with many candidates achieving full marks.

(b) **Average mark 30%** **Response rate 14%**

The first half of the question was reasonably well answered. Many candidates failed to get any marks for their explanation of the action of the transistor as a voltage amplifier. Their sketches often failed to show that the input and output voltages were out of phase.

Many candidates specified where a transistor is used (e.g., it is used in a car) rather than how it is used (e.g., as a switch).

Question 11 **Average mark 47%** **Response rate 63%**

Many answers to the parts of this question were vague, long and incoherent. Many candidates rephrased the questions as their answers. It appears from the level of answering that many of the less able candidates chose this question.

Parts *(c), (d), (e)* and *(f)* were all very poorly answered.

Question 12 **Average mark 60%** **Response rate 95%**

This was a very popular question and it was well answered with the exception of part *(c)* which, like Question 10 *(b)*, was neither popular nor well answered.

(a) The principle of conservation of momentum was well stated. A minority of candidates omitted any reference to an external force. The mass of the expelled gas was calculated correctly by most candidates and most indicated correctly that the direction of expulsion was towards the space station. When explaining the change in direction of travel of a spacecraft candidates often gave long and vague explanations.

(b) Most candidates stated correctly the laws of refraction.
Candidates included too much detail in the diagram of the structure of the eye.
Many candidates were vague on the focussing of the eye.
Many candidates worked out the calculations for the power and focal length correctly, but most omitted the negative sign and many had incorrect units.

(c) Electromagnetic induction and Lenz's law were well stated by the candidates.
Most candidates were not able to explain satisfactorily why the current in the circuit was reduced.

(d) All the candidates recognised Rutherford's experiment. The remainder of this part was well answered.

ORDINARY LEVEL

Section A

Question 1 **Average mark 57%** **Response rate 70%**

The standard of answering was varied for different parts of this question.

The 'labelled diagram', 'procedure', 'other measurement' and 'precaution' were well answered.

The 'outline how you got a value for g' was very poorly answered. Very few candidates achieved any marks for this part. Many candidates described incorrect experiments, e.g., conservation of momentum, measuring acceleration.

Many candidates confused speed with acceleration.

Question 2 **Average mark 70%** **Response rate 83%**

This was the most popular and best-answered question in Section A. All parts were well answered but many candidates had difficulty in determining the relationship between the fundamental frequency and the length from the graph; many candidates omitted the word 'inversely' when mentioning 'proportional'.

Most candidates knew how to set the wire vibrating and how to adjust the length.

Common mistakes included tightening the wire when adjusting the length and plotting f versus l.

Question 3 **Average mark 65%** **Response rate 78%**

This question was reasonably well answered. Some candidates achieved full marks while others had difficulties in calculating the average value for the focal length of the mirror. The labelled diagram, finding the position of the image, and showing u and v were generally well answered. Some diagrams highlighted confusion between lenses and mirrors.

Many candidates had a problem with the addition of fractions. A common mistake was to stop after finding the value for $1/f$.

Question 4 **Average mark 67%** **Response rate 54%**

This question was well answered. Most candidates scored very well on the graph but some were not able to estimate the temperature from the graph when the meter read 740 Ω.

Some candidates had a difficulty in explaining how the temperature was varied.

A common mistake was to suggest using a variable resistor to vary the temperature of the thermistor.

Section B

Questions 5, 6 and 12 were the three most popular questions in this section.

Question 5 **Average mark 60%** **Response rate 93%**

This was the most popular question and was answered well by the candidates.
Parts *(a), (c), (e), (h)* and *(i)* were well answered, while attempts at parts *(b), (d), (f), (g)* and *(j)* were very disappointing.

(b) Many candidates were not able to complete the calculations.

(d) Many candidates stated that increasing the U-value would increase the insulation.

(f) A common mistake was to state that the lens was concave.

Question 6 **Average mark 61%** **Response rate 85%**

This was a popular question and was generally well answered.

Definitions of velocity and acceleration were poorly answered. However, the completion of Newton's first law was well answered.

Many candidates failed to state that the aircraft accelerates when $T > R$. In the final part of the question, few candidates used Newton's law in their explanation. Common mistakes occurring in the calculations included substituting $v = 60$ and not changing km to m or minutes to seconds.

Question 7 **Average mark 38%** **Response rate 51%**

This question was poorly answered.

Explaining refraction and diffraction were generally well answered although many candidates confused diffraction with dispersion. The demonstration of dispersion was well answered but many candidates labelled the light source as 'monochromatic'. Many candidates were unable to name one property that electromagnetic waves have in common and could not describe how infrared radiation is detected.

The calculation of the frequency was poorly answered.

Most candidates could give only one use of microwaves, i.e., cooking.

Question 8 **Average mark 40%** **Response rate 42%**

The level of answering was poor in this question.

The calculations were the only parts of the question answered satisfactorily, but even here candidates had problems with fractions. The section on semiconductors was poorly answered. Many candidates could give only one use of semiconductors.

Question 9 **Average mark 50%** **Response rate 29%**

This was not a popular question with candidates, but the level of answering was satisfactory.

'What is electromagnetic induction?' was poorly answered. Many candidates confused electromagnetic induction with electromagnetism.

Common mistakes included incorrect labelling of the transformer and incorrect interpretations of the statement on the efficiency of a transformer.

Question 10 **Average mark 47%** **Response rate 43%**

The level of answering in this question was satisfactory.

Explaining thermionic emission, use of the cathode ray tube and lead shielding were well answered.

Naming the parts A, B, C and D was poorly answered.

The sketch of the X-ray tube was poorly answered.

A common mistake was to confuse the anode with the cathode.

Question 11 **Average mark 50%** **Response rate 63%**

The level of answering was generally satisfactory.

Parts *(a), (b), (e)* and *(h)* were well answered but parts *(c), (f)* and *(g)* were poorly attempted.

(d) Many candidates gave 'radiation' as the answer.

(e) Most candidates gave 'iodine' and 'caesium', which were given in the text.

(f) Most of the answers to this part were vague.

(g) A common mistake was to confuse background radiation with fallout radiation resulting from a nuclear explosion.

Question 12 **Average mark 56%** **Response rate 82%**

This was popular and generally well answered. Parts *(a)* and *(b)* were the more popular.

(a) This part was well answered.
Most candidates mentioned 'force' in the definition of pressure but a common mistake was to omit 'per unit area'.
Most candidates knew the correct unit while others gave an incomplete unit, e.g., N.
The explanation of the metal container collapsing was poor. Candidates were able to calculate the pressure at the wall.
A common mistake was to state that a hydrometer was used to measure pressure.

(b) The definition of specific heat capacity was reasonably well answered, as was the calculation of the energy and why the heating element was near the bottom of the kettle. However, the calculation of the power was not well answered. Many candidates failed to convert minutes to seconds.
A common mistake by candidates was to take the change in temperature as 100 °C.

(c) This part was not popular and was very poorly answered.
Many candidates could not define capacitance.
The descriptions and explanations by candidates of what happens in circuits A and B when the switch is closed were vague and poor.
Candidates described reasonably well the experiment to demonstrate that a capacitor can store energy.

(d) This part was not popular and was very poorly answered.
Diagrams showing the magnetic field lines were vague. Very few indicated the direction of the magnetic field lines.
While some candidates gave good descriptions of the experiment to demonstrate force on a current-carrying conductor, many confused the experiment with one on electromagnetic induction.
Most candidates were able to list two factors that affect the size of the force.
A common mistake was to describe the experiment showing that opposite charges repel each other.

4. GENERAL COMMENTS

- It is encouraging to see an increase of 6% in the number of candidates taking physics at Higher Level.
- By comparison with 2001, there is an increase of 1.6% at Higher Level and an increase of 4.1% at Ordinary Level in the number of (A+B+C) grades awarded. It is disappointing that there is not an increase in the number of A grades at Higher Level, particularly since the revised syllabus is shorter that the previous syllabus. There is a 4.5% increase in the number of A grades awarded at Ordinary Level.
- Examiners agreed that the papers were reasonable and fair. The examiners have commented on a decline in the standard of answering. This arose mainly from a lack of precise knowledge of definitions, an inability to manipulate formulae and a lack of clarity in written expression.

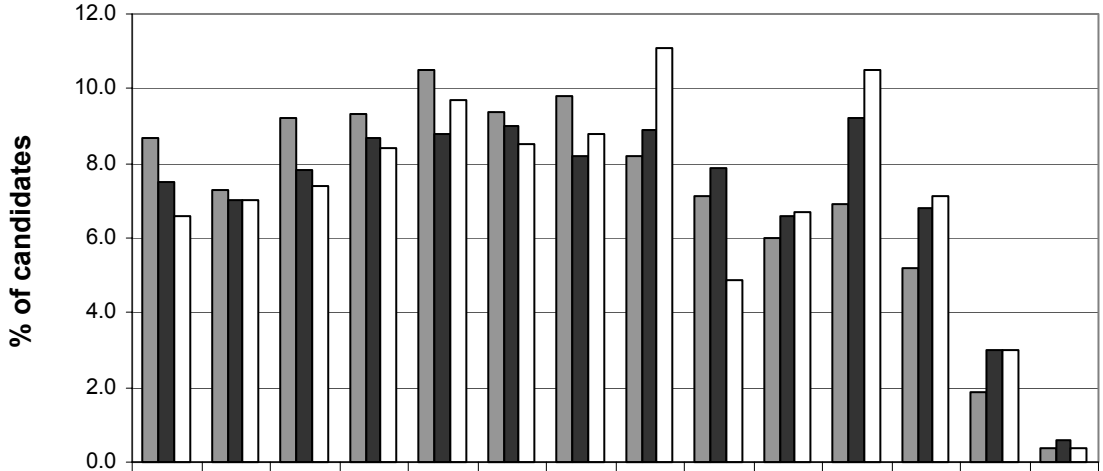
- The format of the paper did not cause any difficulty for the candidates but the absence of multiple choice and completion-type questions gave more opportunity for long and vague answers. This made it difficult for the examiners to decide if the appropriate information was present.
- Candidates showed a good knowledge of the experiments listed in the syllabus. Most candidates scored well in Section A, but the work of less able candidates lacked detail and many gave vague or incorrect descriptions of the experiments.
- Definitions and laws were answered satisfactorily. While candidates seemed to know the laws, their knowledge of the implications and applications of the laws was very often poor.
- Candidates scored reasonably well in the Science, Technology and Society (STS) aspects of the paper but less able candidates were often unable to give applications when required. The full STS question seemed to be an attractive question for candidates, but most failed to achieve high marks in it.
- Able candidates wrote more than in previous years. This may be a direct consequence of the new format, which requires candidates to answer eight structured questions. On the other hand a greater number of less able candidates wrote less than in previous years.
- Diagrams were generally used to support written answers, where appropriate. The diagrams were usually well drawn and labelled and able students used them to complement explanations/descriptions.
- Units were often omitted or incorrect.
- Where candidates did poorly, there were three major causes: not answering enough questions, not knowing enough physics; and not being able to calculate correctly.
- There was a marked tendency for candidates to avoid questions on electricity. Candidates displayed a poor knowledge of semiconductors.
- A significant majority of the Higher Level candidates chose to answer the question on particle physics rather than the question on applied electricity.

5. RECOMMENDATIONS FOR TEACHERS AND STUDENTS

- It is essential that students cover all sections of the syllabus and that they answer the required number of questions.
- It is important that plenty of experiments and demonstrations are carried out. Many students do not seem to understand scientific method, and have difficulty in data handling and in presenting results.
- Students need to experience a wide variety of practical and relevant situations in which they can apply their knowledge of the laws and concepts of physics.
- Students need to integrate their knowledge of physics with everyday experiences to enhance their understanding of the STS aspect of the syllabus.
- Students need to be able to express their understanding of physics concepts in language that is clear, concise and correct.

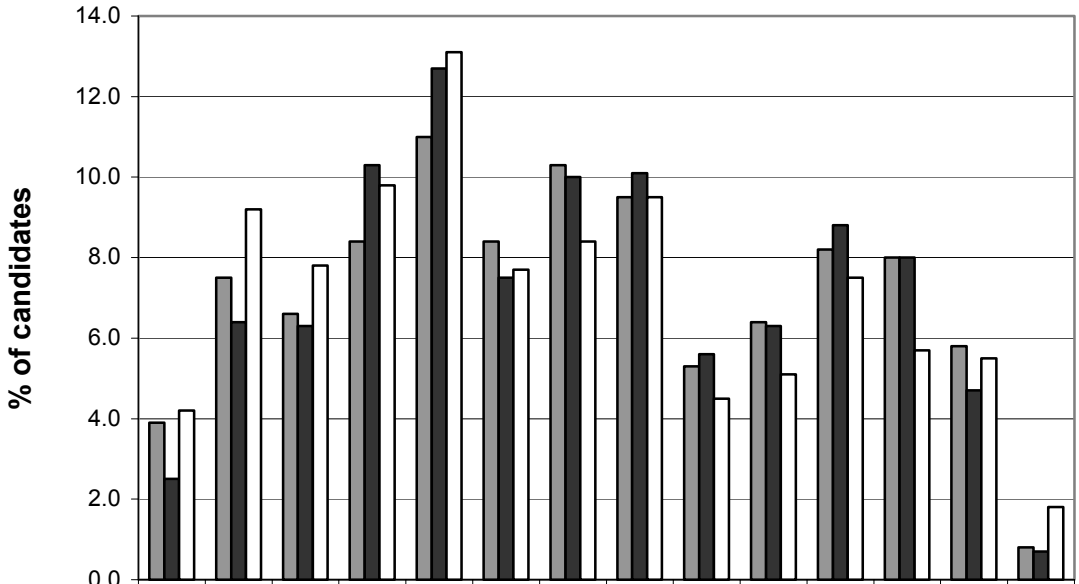
APPENDIX

Physics Higher level grade distribution 2000-2002



	A1	A2	B1	B2	B3	C1	C2	C3	D1	D2	D3	E	F	NG
2000	8.7	7.3	9.2	9.3	10.5	9.4	9.8	8.2	7.1	6.0	6.9	5.2	1.9	0.4
2001	7.5	7.0	7.8	8.7	8.8	9.0	8.2	8.9	7.9	6.6	9.2	6.8	3.0	0.6
2002	6.6	7.0	7.4	8.4	9.7	8.5	8.8	11.1	4.9	6.7	10.5	7.1	3.0	0.4

Physics Ordinary level grade distribution 2000-2002



	A1	A2	B1	B2	B3	C1	C2	C3	D1	D2	D3	E	F	NG
2000	3.9	7.5	6.6	8.4	11.0	8.4	10.3	9.5	5.3	6.4	8.2	8.0	5.8	0.8
2001	2.5	6.4	6.3	10.3	12.7	7.5	10.0	10.1	5.6	6.3	8.8	8.0	4.7	0.7
2002	4.2	9.2	7.8	9.8	13.1	7.7	8.4	9.5	4.5	5.1	7.5	5.7	5.5	1.8