APPLIED STUDIES

In 1995 947 candidates presented for this examination, an increase of approximately 32% over the candidature for 1994. The following is a breakdown of the percentage of students attempting each section.

1 UNIT

Section		%
1	Application of Computer Controlled Systems	5
2	Applied Mathematical Skills	5
3	Mathematical Ideas	2
4	Science and Medicine	18
5	Scientific Research	11
6	Significant Technological Achievements	8
7	Statistical Methods	4
8	Technology and Consumers	15
9	Technology and Communication Systems	9
10	The Environment	21

The responses show an improvement in the understanding of the Syllabus, but some candidates still appear not to possess the required knowledge. Schools are advised to keep abreast of the changing topic(s) in some areas by reading the Board documents such as the *Prescribed Texts, Topics, Projects and Works document.*

1995 HIGHER SCHOOL CERTIFICATE EXAMINATION

Question 1 : Applications of Computer-Controlled Systems

(a) The most succinct answers for this section were well drawn and labelled block diagrams as shown in the Syllabus Support Document. The majority of students were able to present a reasonable representation of an open loop system, but fewer students correctly represented the closed loop system.

(b) (i) This part was generally well done, although it was not uncommon in part (i) for students to give the name of the sensor and fail to indicate what it measured.

(ii) The most common response in (ii) was the *motor*.

(c) (i) It was important that students should indicate specific examples of types of sensors and/or actuators. It was not considered sufficient to say that, in response to the sensor, *the door would open*. A correct response indicated that the sensor would cause the controller to respond by activating the motor which caused the door to open.

This part was not well done. The basic systems were not well explained, although the safety devices/arrangements in parts (ii) and (iii) were well covered. Sketches and diagrams provided as part of the answer were not clear.

(ii) Time alone was not considered to be adequate enough protection against being trapped in the door. In discussing how to prevent dogs from activating the mechanism it was most common for height and weight sensors to be described.

(iii) The best answers to (ii) and (iii) were those that explained the type of sensor and the consequent action.

(d) This part was poorly answered. It is emphasised that the Syllabus specifies that a model of a computer-controlled system should be constructed.

(i) It is essential for the difference between computer-controlled systems and simple *timer* or *battery* operated devices such as model cars or trains, to be emphasised; students should be made aware of what specific function the computer executes as part of the total system.

(ii) This part was often not attempted; when it was attempted, responses were generally very poor. Any form of logical statement regarding the process/function of a computer-controlled system was accepted, although it was expected that students would know and understand the graphic form.

(e) The part relating to changes in work practice was not well understood. Most answers indicated the results of the introduction of the system from the point of view of efficiency or production rather than changes in work practice such as:

> machines being controlled by a computer - people *monitor* the process rather than carry it out;
>
> data handled by computer - people *enter data* rather than *process calculations*.

<u>Question 2</u> : <u>Applied Mathematical Skills</u>

(a) This part was answered poorly, since most students appeared to find the mathematical skills and concepts too difficult.

Candidates who responded with a table of numerical methods were successful. Those who attempted drawing a graph to solve the problem were confused by the introduction of a second variable, hence their poor results.

The most common error was failure to take the following into account:

(i) the backing occurred after 60 minutes;

(ii) a new person was introduced at this point, and

(iii) the machine was <u>still</u> producing more bottles.

Many successful answers were achieved by using simple algebra and logic.

(b) Again, interpretation of the question proved to be a problem, with students failing to recognise that the increase occurred from the <u>beginning</u> of one year to the next.

The most common error in this part was students' failure to convert the increase into a percentage. These candidates were able to calculate the increase per year by calculating the difference, but proceeded no further.

The best response was given by those who calculated the greatest difference as a percentage and gave a statement verifying the time period when this maximum occurred.

(c) (i) This was the best answered section of the question as most students chose to use the formula which required basic substitution in solving the equation.

The most common errors occurred because students

(i) did not use the formula but, rather, opted for other methods;

(ii) were unable to solve the equation to find *r*.

(ii) Most students were able to substitute their value for r from part (i) successfully into the formula and thus obtained the result.

The most common error occurred when students attempted to solve the problem by using other methods.

(d) (i) Many candidates misinterpreted the wording of the question, and assumed it implied **not** a period of time **but** a particular day.

Students needed to look for the steepest part of the graph, not the highest point, as many of them did.

(ii) Most students understood that the rate of increase implied a change, hence calculation of the gradient was required. Those who found this successfully calculated the change.

(iii) Many students understood neither the special characteristics associated with a Logistics Curve nor the circumstances under which it applies. They were unable to identify the main features of the specific type of growth.

(iv) Candidates were unsure of the difference between the Logistics Curve and the Malthusian Curve, hence the responses were varied.

This was a simple definition application and, as such, straightforward. Students need to understand the difference between the two laws.

Question 3 : Mathematical Ideas

(a) (i) Few students knew the true definition of *pi* (π), i.e. the ratio between the circumference of the circle and its diameter. Marks were still awarded, however, if they explained pi as having an *approximate* value of 3.14 and also that it is used in calculating the circumference or area of a circle. Because of the way in which the question was worded, i.e. "*What* is pi? (π)", it was not imperative for them to give the *true* definition as the question did not ask for the formal definition. Most students received either half or full marks for this question.

(ii) This part of the question was answered well, on the whole. It was obvious that most students had attempted a practical activity in relation to finding *pi* (π) or a practical simulation of the estimation of *pi* (π), because they were able to explain their experiments well.

Buffor's probability experiment - which is a simulation of the estimation of *pi*, was a popular answer and most students were able to explain how *pi* could be estimated from it.

Archimedes' method of inscribed or circumscribed circles was the most popular answer and the majority of students were again able to explain how *pi* (π) could be estimated from it, i.e. $\pi = \frac{circumference.}{diameter}$

(iii) On the whole this was a poorly answered question, for which few candidates received full marks. The main problem was that the majority did not know the definitions of either a rational or an irrational number.

Few students knew the formal definitions of a rational number, i.e. any whole number that can be expressed in the form of $\frac{a}{b}$ and b $\neq$ 0.
Again, because the question did not ask for a formal definition, most candidates gained some marks by making a collection of true statements about either a rational or an irrational number with appropriate examples, e.g. *a rational number is a whole number, can be positive or negative, a fraction or a decimal, e.g. integers 0-9, or .5 or* $\frac{1}{2}$.

A number of candidates incorrectly stated that a recurring decimal, such as 1.33, is an example of an irrational number; recurring decimals are classed as rational numbers by definition, even though the decimal places go on forever. Many students also failed to give two examples of each; two surds such as $\sqrt{5}$ and $\sqrt{2}$ were accepted as two examples of an irrational number; some students gave only one example or failed to give any examples in their answer.

(iv) Students answered this question well. The majority understood that, because a final decimal place was found, it was assumed to be a rational number.

The second part of the question, viz, *Is this conclusion valid?*, was not well answered. Students tried to explain that computers either do/do not make mistakes, rather than explaining the meaning of a rational number.

(v) Most students were able to recognise some clue in the article which could have alerted the journalist to the fact that a practical joke was being played. The most popular choice was *pi ends at 2075932542102*, or *the computer started printing millions of zeros*. Because the students were not required to explain why they chose their specific clues, most were rewarded for answers such as the above.

(b) (i) Students were required to indicate the first three stages of a given fractal. This question was not handled well by most candidates, many of whom chose to ignore the given fractal and used their own which they had learned in class. This showed a poor understanding of the definition of a fractal, indicating that, possibly, more examples of fractals and more practice is needed for students to feel confident with this mathematical concept.

(ii) This was not very well answered; many failed to explain fully their fractal and the mathematical pattern behind it. Here it was sufficient for students to describe what they had generated in the previous part.

(iii) This part apparently confused students who had failed to answer the previous two parts well. Those who did answer (i) and (ii) correctly also answered (iii) well.

(iv) Again, if (i), (ii) and (iii) were answered well, this part was also answered well.

(c) (i) The majority of candidates were able to explain that a satellite stays in geostationary orbit because it has an angular velocity equal to Earth's rotational velocity, thus making it appear stationary. They could then deduce that it was Earth's gravity, or gravity from somewhere combined with the satellite's orbital velocity, that kept it geostationary. It seemed that students either answered this question or omitted it, which perhaps indicated that they either knew the topic or they did not.

(ii) This question was, on the whole, poorly answered. More care was needed in reading and interpreting the question.

A number of students gave the *uses* of a geostationary satellite, e.g. communications, weathering, not the *reasons* for having a satellite geostationary, i.e. for tracking and cost purposes (cheap on fuel). Marks were lost for giving *uses* rather than *reasons*.

Question 4 : Science and Medicine

Answers to all sections were poorly expressed.

(a) Most students referred to ultrasound or CAT scans and X-rays as examples, but few attempted radioisotopes.

(i) A number of answers lacked specificity and did not show an understanding of the scientific principles on which the techniques were based. Many responses were based on personal experience rather than a scientific basis.

(ii) Many students apparently found this question hard to understand. The difficulty seemed to arise from the use of the words *in terms of the scientific principles outlined in part (a)(i) above*. As a result, this question was poorly answered. A number of students simply restated their answer to (i) or said *images were fuzzy* or *the images needed to be interpreted by professionals*.

(iii) Limitations for ultrasound use were generally well known; students often stated only one limitation for radioisotopes and CAT scans/X-rays.

(b) (i) Students were able to state a testable hypothesis for the stated belief. Many, however, appeared to have no conception of how to formulate a hypothesis.

(ii) Many students could not describe an appropriate experimental design to test the given hypothesis. Most did realise that two or more groups were required and, as a result, statements about:

- ideas of standardisation of subjects
- large group size
- duration of experiment
- properly designed control and experimental groups
- recording of results

were often omitted.

(iii) A number of students could not identify the dependent variable; the concepts of dependent and independent variables need to be stressed.

(iv) The majority of students understood the concept of a placebo, although their answers were often poorly expressed.

(v) Most did not understand the concept of blind testing.

(vi) This question was poorly answered, since most students were unable to generalise from their specific experiment. Concepts of ethics were poorly understood, both here and in the following part.

(c) This question was answered more fully than part (b)(vi), with most students gaining good marks. It was apparent that many students had some difficulty in understanding the notion of *genetic copies* of animals such as cattle.

A number of students responded emotionally because many had had some contact with/experience of ethical and genetic issues.

Question 5 : Scientific Research

(a) A small percentage of students failed to show that this was a research project that they had designed and performed themselves.

(i) The weaker students had a limited knowledge of their research project and did not know the aim of their experiment.

(ii) The better students stated a hypothesis that could be tested by their project. The weaker students could not define a hypothesis; consequently, many answered with a question instead of a statement.

(iii) Many candidates could not differentiate between the dependent and the independent variable. Some listed controls or the items they were testing.

(iv) A large number of students could give valid reasons for reviewing the literature before designing the research project. On the other hand, the weaker candidates expected the literature to tell them what to do.

(b) (i) Many of the weaker students chose examples of Australian-based research projects not on the current prescribed list.

(ii) A number of students could not state the questions the project was meant to answer. Consequently they had problems in answering parts (iii) and (iv) correctly.

(iii) Many students answered this well and gave clear details of the way in which the project was carried out. A few stated how the information was obtained but failed to describe how the project was carried out.

(iv) Many students did not understand the need for a control and failed to see where it fitted into their project.

(c) (i) A small number of students could not give the correct formal hypothesis for the given experiment.

(ii) Many of the students understood that the role of Group A was to compare the teaching methods, and named it as the control group.

(iii) A number of students understood that the assessor could be biased and expanded upon this.

(iv) The best students were able to give good reasons to show why each teacher should teach his/her own method and also indicated that possible intentional bias could result if this were not the case. Weaker students did not discuss all the implications fully.

(v) Good students clearly explained why the stated conclusion was not valid. Weaker students did not appear to understand what was being asked, and some even attempted to explain why the result was valid.

<u>Question 6</u> : <u>Significant Technological Achievements</u>

Those who attempted this question were instructed to answer *in terms of a significant technological achievement drawn from the given list*. There were a number of students who either had not fully prepared themselves for this question or did not read the instruction carefully. Often they named achievements that were:

- not on the list,
- which were selected from outside the "area",
- which included *two* achievements from one area when only ONE was required.

(a) (i) Students were required to write the name of one achievement drawn from the given list. A sample of papers indicated that the three most popular achievements chosen were:

milk products,
integrated circuits, and
the assembly line;

with the least popular achievements being:

PET,
grape products, and
superwash wool.

(ii) Many candidates simply stated that they had conducted research or that they had *phoned some companies* or *watched videos*. **These are not adequate practical activities.** A typically good response included a full description of washing a sample of superwash wool a number of times and then comparing it with an ordinary wool sample washed the same number of times to test the shrinkage and felting.

(iii) In this part the candidates were required to explain how the practical activity described in (ii) improved their understanding of the achievement named in (i). Many received no marks for this section because they simply stated *"the practical activity did improve my understanding"*. To gain full marks candidates were required to explain fully *why* the achievement is considered *significant*. High marks were awarded to students who referred not only to the reasons for shrinkage and felting in ordinary wool but also to the treatment of the superwash wool which prevents these problems.

<u>Question 7</u> : <u>Statistical Methods</u>

(a) This was the best answered part of this question since students showed a good understanding of normal distributions and how skewed results can be obtained.

(i) 90% of the candidates were able to draw a normal distribution curve.

(ii) Here many candidates confused *range* of IQs (55-145) with a measure of spread of scores.

(iii) This question was based on definitions of *mode* and *median*.
A number of candidates correctly stated that, on a normal distribution,
mean = mode = median.

A number of students incorrectly stated *the median is the middle; hence 100 ÷ 2 = 50 or the mode is the most result hence it lies within 68% of the mean*. They confused their definitions of normal curves with those of mode and median. Many did not give reasons for their answers.

(iv) The majority of students were unable to explain why the *weights* of Australian adults do NOT follow a normal distribution. They were required to state more than *because everyone's weight is different* or *some people's weights change as they go on diets*. Such responses do not explain why weight does not follow a normal distribution.

The best responses came from those who stated that the skewed results were due to the Australian lifestyle. In other good responses candidates stated that females and males have different upper and lower limits, hence weights would be bimodal.

Candidates really needed to *explain* why the distribution is not normal, including giving an alternative distribution, e.g. skewed or bimodal.

(b) Students either did poorly or very well in this section, depending on whether or not they knew the z-test:

$$z = \left| \frac{x - \bar{x}}{s / \sqrt{n}} \right|$$

x = score value (given)

$\bar{x}$ = mean

s = standard

n = number of scores

If z > 1.64, the statement is invalid.

If z < 1.64, the statement is valid.

The majority discussed standard deviations away from the mean, avoiding the use of the z-test.

Marks were awarded for correct statistical calculations, but many found it difficult to calculate mean and standard deviation.

(c) Candidates appeared confused with this section, and many were not familiar with statistical terms such as *stratified random sampling*. They found it difficult to apply their knowledge of statistical data to forming conclusions and analysing factors involved in the survey.

(i) Here students needed to define *stratified* and show how they could apply their definition to the given problem. The best responses discussed the stratification process and the fact that the group would need representative samples from each stratum.

Most students discussed random processes of selection; many misinterpreted the question and discussed the location of the airport rather than the flight path.

(ii) This question was answered well since most students understood that, if the schools were being affected, then the survey had to be conducted during school hours.

(iii) The majority were unable to list two <u>other</u> factors, and limited themselves to distances from the airport or flight path and considered neither who was being surveyed nor the conditions of the survey.

1995 HIGHER SCHOOL CERTIFICATE EXAMINATION

Question 8 : Technology and the Consumer

(a) (i) A small number of candidates failed to chose a product or category from the list supplied on the examination paper. Students need to be aware that the list of consumer products or categories is mandatory and is contained in the current Prescribed Texts, Topics, Projects and Works document which is produced yearly.

(ii) Many students answered this question badly. Low marks were awarded to candidates who described the physical operating principles, e.g. which buttons to press in order to make a magnetic tape play music.

The better candidates knew the meaning of *technological and scientific principles*, and described the specific aspects necessary for their category or product, e.g. many described the operation of the portable musical player by referring to *magnetic tape storing information through patterns of the magnetic material, and the passage of this tape past a magnetic head*, etc.

Students may need to be exposed to case studies in order to improve their understanding of what is required in answering questions on this area.

(iii) Most students gave an appropriate response to this question by referring to specific materials, e.g. aluminium, stainless steel, plastics.

Some of the weaker responses included general names, such as *metals, chemicals*, with no greater detail. Students do need to have a knowledge of the specific names of the material used in the product or category. Some had a poor knowledge of the main materials used in the product or category.

(iv) Good responses mentioned or described features that were specifically designed as safety features. Weaker responses referred to general features that were not designed as safety features.

(v) Answers to this question were generally good. Most students mentioned Australian Standards, parts and labour, length of warranties, etc.

(b) (i) Again some students failed to choose from the prescribed list given on the examination paper.

(ii) Many responses to this question were poor, with students listing *components* of a marketing strategy rather than two marketing strategies, e.g. a TV or newspaper advertisement. A strategy, as described in the Syllabus Support Document, is *a sequence of events or a series of steps*.

The better candidates described whole strategies in their response.

(iii) Generally this part was poorly answered. Some weaker candidates obviously had no idea of the meaning of *aesthetic qualities*; the better candidates, however, talked about *appearance, status, product recognition*.

(iv) Many students were confused by this question and talked about how the whole product is an improvement on what was previously available.

Few students discussed how ease of use has been improved. Those who did so talked about specific improvements in the product.

(c) (i) Poor candidates obviously failed to interpret the table accurately. Interpreting tables of this type requires practice throughout the study of the topic; many would benefit from practice in dealing with this type of problem.

(ii) Students obviously lacked practice in answering this type of question, and many were unable to interpret the table in order to answer the question.

(iii) There is obviously a need for explicit study of legal consumer issues, since students did not know the reasons for including the table of contents on packaging.

Question 9 : Technology of Communication Systems

(a) (i) Systems that were appropriate included:

- morse code
- messenger
- semaphore
- light beacons
- smoke/fire
- telegraph
- carrier pigeon
- telephones
- horns (or any other device that makes a noise), and
- mirrors.

It was inappropriate to choose radio or the Internet.

(ii) Limitations of the specific system varied according to the system selected in (i). The following issues were, however, included:

- distance;

- the message may be broadcast to an unintended audience (as in the case of systems such as semaphore and light beacons);
- the system may require trained operators;
- in some of the systems, people always need to be on the lookout for the message; and
- the systems are susceptible to the elements (e.g. bad weather, time of day).

This part was generally well answered.

(iii) This part was, on the whole, poorly answered. Stating that the system was appropriate because it did not use technology was not considered acceptable.

The appropriateness of the technology chosen was related to factors such as:

- cost of construction and maintenance;
- availability of materials to build and maintain the system;
- availability of expertise to build, use and maintain the system; and
- the ease with which it would perform the required task.

(iv) Many students said that there was no noise in the system (e.g. light beacons, smoke signals, etc). In other cases students repeated some of the points they raised in (ii), which was acceptable. Noise could be identified in some systems more readily than in others. For example, it was easier to identify noise in a system such as the telegraph than, for example, the carrier pigeon. The following is a sample of what some students included:

- telegraph — electric storms, poor connections, corroded wires;
- beacon — time of day, fog/rain/cloud, trees and physical impediments;
- smoke signals — wind or other unfavourable weather conditions, time of day, presence of other fires.

Question 10 : The Environment

Part (b) was better answered than parts (a) or (c); many candidates appeared to believe, wrongly, that dam storage was small.

(a) Most students did not connect the problem in the dam with possibly the surrounding farmlands or a town. They did not see the problem as one of contaminated run-off. Many treated the conditions existing in the dam as being an isolated case.

A number of responses referred to *stagnant* conditions in the dam (water storage).

There was a general misconception that the dam storage was small.

The majority of students could identify the specific contaminants in the run-off in the catchment area.

A number could identify a specific test for their chosen contaminant, viz. phosphates, e coli, pH, algae.

Many candidates did not interpret the question correctly and so failed to gain full marks. The question clearly stated appropriate measures, some of which were:

- preventative farming practices;
- removing macrophytes from the water surface;
- public education campaigns;
- tertiary treatment of sewage.

Specific treatments given included:

- filtration;
- aeration;
- chlorination;
- boiling;
- domestic filter.

(b) This was generally well answered, although a few problems arose from failure to understand the process of salination. Some very vague geographical locations were given by students.

(ii) Here students needed to be aware of efficient irrigation practices which minimise salination problems, e.g. drip irrigation methods, tiled drains.

(iii) Only a small number of candidates gained full marks, since, other than extraction, few other plausible business ventures were given. In some responses students suggested that suitable activities could be nurseries of salt resistant/tolerant plants, irrigation equipment and drainage piping.

(c) (i) Many students had difficulty in relating their local environmental issue to the global context, nevertheless some good local case studies were given. These included livestock dip sites, disposal of intractable waste, stream watch, local salinity studies on agricultural properties.

(ii) Many responses were vague since, although the students could expand on their methods of research, they lacked knowledge of the underlying scientific principles.

(iii) Answers here were generally good and were obviously based on wide knowledge.

(iv) Most students gave solutions that would benefit the local economy. Many, however, did not list/give examples in terms of economic advantage to the local community. Such students did not appear to understand the question.