BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

1996

APPLIED STUDIES

1 UNIT

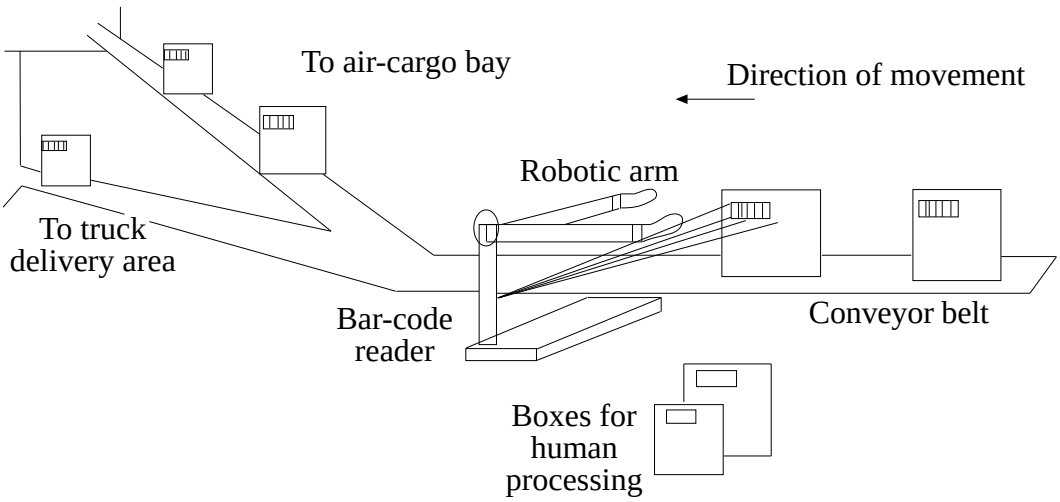
Time allowed—Two hours
(Plus 5 minutes' reading time)

DIRECTIONS TO CANDIDATES

- Attempt THREE questions.
- Each question is worth 20 marks.
- Board-approved calculators may be used.
- Answer each question in a *separate* Writing Booklet.

QUESTION 1. Applications of Computer-Controlled Systems **Marks**

(a) A robotic device in a production line scans a bar-code on the packing label of large boxes as they come off the production line. The box is moved to the correct conveyor belt for delivery to either a local or international destination. Those boxes which are missing labels are removed from the production line for 'human processing'. Local items are moved via the conveyor to the delivery truck; the others are moved to a loading bay and stacked for transport to the air-cargo terminal once a day. **8**



(i) Write an algorithm to control the activities of the robotic device.

(ii) State TWO reasons why a robotic device was developed to do this job.

(iii) Give TWO probable effects that the introduction of this robotic device has had on each of the following:

1. those who were doing the job previously;

2. the industry.

(b) As part of your studies, you have assembled a computer-controlled system. **7**

(i) Draw a labelled block diagram of the system you have studied, indicating the key components and function of the system. On this diagram identify one sensor and one effector (actuator).

(ii) Describe the principles behind the way the sensor and the effector work in part (i).

(iii) Discuss TWO implications, to the real world, of the use of systems such as the one you assembled.

QUESTION 1. (Continued) **Marks**

(c) A computer-controlled device automatically records information on noise levels experienced by a hospital. The hospital is under the flight path of a busy city airport and is also on a busy road. **5**

The hospital has sensors on the roof to record noise levels in decibels and the duration (length of time) of any level over 70 dB. Movement sensors also record any vibrations experienced on the roof of the hospital.

Twice each day, the data is automatically transmitted to a central collection point for processing.

(i) List and describe THREE advantages of a computer-controlled device collecting the data.

(ii) Describe TWO disadvantages of the running of a monitoring system that collects data and is totally controlled by computer.

QUESTION 2. Applied Mathematical Skills **Marks**

(a) (i) If you invested \$10 000 at an interest rate of 5% per year, compounded yearly, how long would it take to double? Show all necessary working. **5**

Use the formula $A = P\left(1 + \frac{r}{100}\right)^n$.

(ii) Is the time for \$30 000 to double, at the same rate of interest as in part (i), the same as your answer in part (i)? Explain briefly.

(iii) A bank's 'Handbook for Customers' suggests the rule: 'To get an approximate idea of how many years it takes for money invested at x% a year to double, divide x into 70'.

Do your answers in part (i) and part (ii) agree with this rule? Show all necessary working.

(b) In an assembly line, three machines are used to process a queue of car parts. The car parts arrive at a rate of three per minute, and each machine processes one per minute. **3**

The human supervisor leaves for lunch at 1 p.m., noting that all three machines are working correctly and there is no backlog. One machine breaks down at 1.20 p.m. and a second breaks down at 1.40 p.m., but the third keeps working.

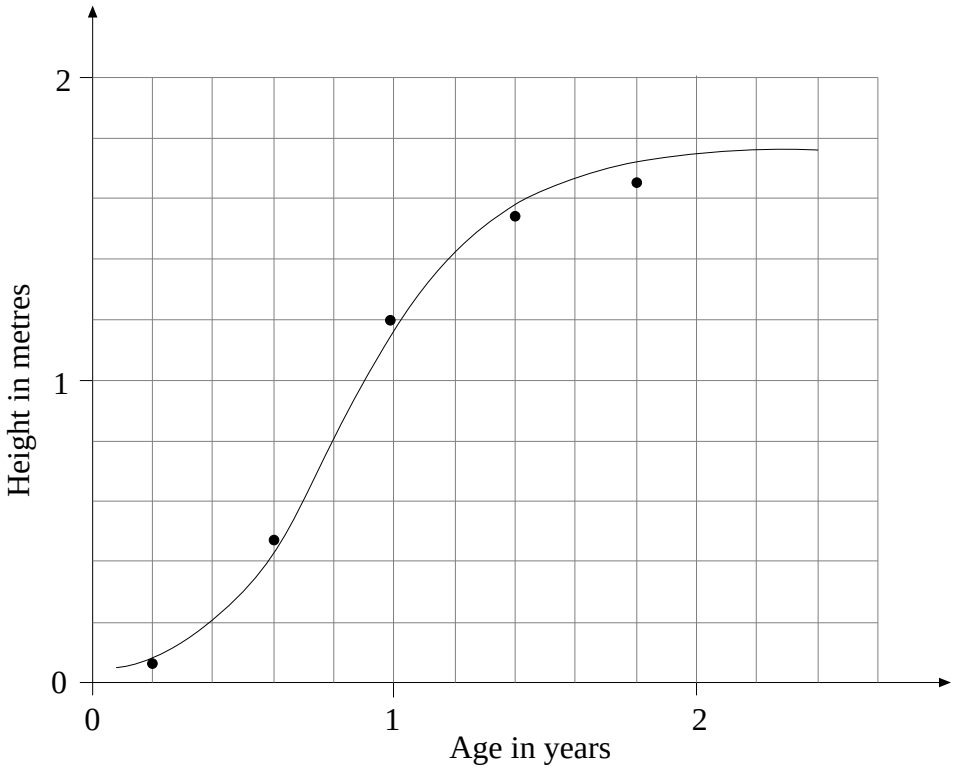
How long will the backlog be when the supervisor returns at 2 p.m.?

QUESTION 2. (Continued) **Marks**

(c) A researcher observes the growth of 100 acacia seedlings, measuring them and recording the average height at intervals of 0·4 years. The results are as follows: **6**

Age in years	0·2	0·6	1	1·4	1·8
Height in metres	0·08	0·49	1·20	1·53	1·64

The researcher graphs these figures and fits a curve, to model the growth, as shown below.



(i) Name the type of growth and describe its main features.

(ii) What is a reasonable estimate for the average height of 0·5 year old acacias?

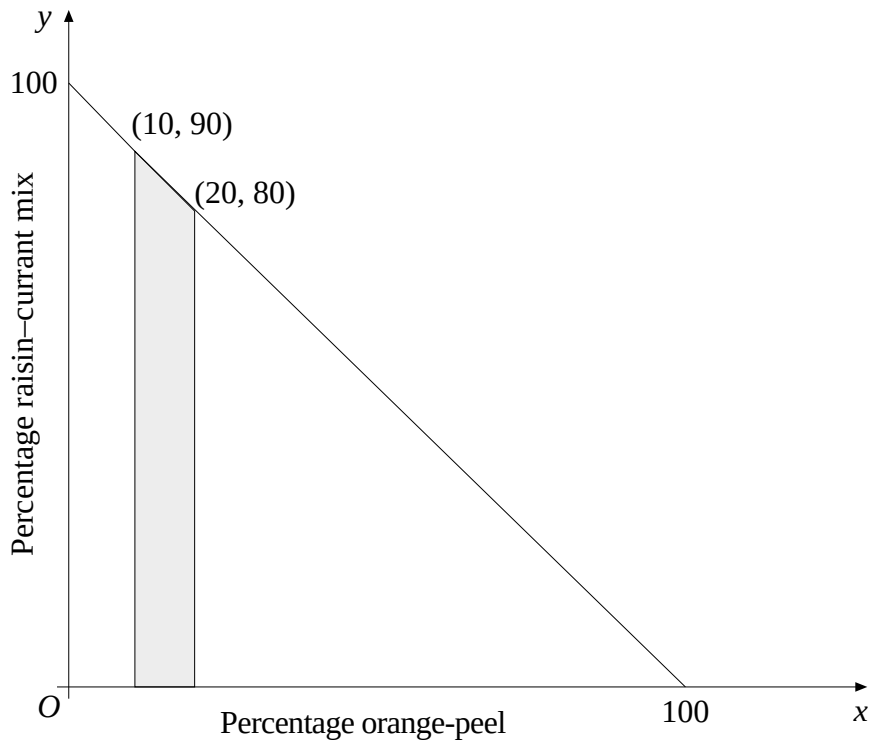
(iii) How old are the acacias when they reach two-thirds of their full height? Show all working.

Question 2 continues on page 6

QUESTION 2. (Continued) **Marks**

(d) A manufacturer of fruit mixture for Christmas puddings will use as ingredients a raisin–currant mix and orange-peel. The raisin–currant mix costs 70 cents per kilogram and orange-peel costs 30 cents per kilogram. Surveys indicate that customers are dissatisfied if more than 20% orange-peel is used, but that any less than 10% orange peel makes the mixture look too dull. **6**

To find the cheapest mixture that will satisfy the customers, the graph below is drawn.



(i) Explain why the answer must lie on the line $x + y = 100$.

(ii) What proportions of the raisin–currant mix and orange peel give the cheapest fruit mixture, subject to the constraints? Show all necessary working.

QUESTION 3. Mathematical Ideas **Marks**

(a) (i) Draw diagrams of Ptolemy's and Copernicus's models of the solar system. Show only the Sun, Earth and Moon, and their orbits. **5**

(ii) What is the most important difference between the two models?

(b) One series approximation to π is **5**

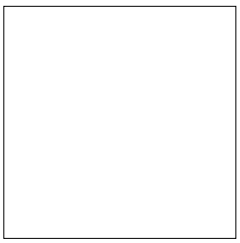
$$\pi = 4\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \ldots\right).$$

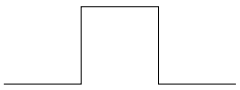
(i) Find the approximation (correct to 3 decimal places) given by the first five terms. Show all necessary working.

(ii) Copy the series approximation and include the next TWO terms.

(iii) How many terms need to be taken before the approximation is between 2·95 and 3·30? Show all necessary working.

(c) The first stage of a fractal is generated by replacing each side of **5**

the square 

with the generator 

(i) Construct the first and second stages of the fractal.

(ii) If the area of the original square is 9 square centimetres, what is the area enclosed by the first stage of the fractal?

(d) (i) Explain carefully ONE of Euclid's axioms. (You may include a diagram if relevant.) **5**

(ii) Discuss the role of Euclid's *Elements* in the development of proof and the axiomatic method.

QUESTION 4. Science and Medicine **Marks**

(a) You have used one of the following diseases as a case study: **8**

- asthma
- anaemia
- diabetes
- malaria
- smallpox
- tuberculosis.

Choose ONE of these conditions from the list.

(i) Name the disease studied.

(ii) How does this disease affect the healthy functioning of the human body?

(iii) How have the causes of this disease been identified?

(iv) In the light of your answer to part (ii), discuss TWO signs or symptoms characteristic of this disease.

(v) What is the initial treatment for the disease? Explain why you might expect this treatment to be effective.

(vi) Detail any possible side-effects of the treatment described in part (v).

(b) You have studied ONE of the following diagnostic imaging techniques: **2**

- ultrasound
- radioisotopes
- X-rays and CAT scans.

All these techniques are becoming increasingly complex, and are giving more information to the doctor. This can, however, lead to misdiagnosis.

Explain how this may occur for the technique you have studied.

(c) Sun exposure and skin colour have been linked to the development of skin cancer. Australia now has the highest incidence of skin cancer in the world. The incidence has been steadily rising for the past thirty years. **3**

(i) How would you investigate the TWO factors that have contributed to skin cancer in Australia?

(ii) Do you believe the incidence will continue to rise in the next thirty years? Justify your answer.

QUESTION 4. (Continued) **Marks**

(d) A small team of researchers at an Australian university has been trying to identify risk factors predisposing people to the development of skin cancer. In a preliminary study involving 150 people of all ages, with and without skin cancer, they noted a strong relationship between skin cancer and hair colour: **7**

Hair colour	*Total*	*Number with skin cancer*	*% with skin cancer*
Brown	50	14	28
Blonde	40	2	5
Grey	40	18	45
Black	18	4	22
Red	2	1	50

(i) Of the people studied, which hair colour group has the highest percentage of skin cancer?

(ii) Of the people studied, which hair colour group has the lowest percentage of skin cancer?

(iii) The team of researchers rejects the obvious conclusion that redheads in general have the highest level of skin cancer. Why?

(iv) The researchers conduct a simple statistical analysis of the hair colour groups referred to and find that grey-haired people statistically have a highly significant elevated risk of skin cancer by comparison with the whole population.

1. Suggest a possible reason for this observation and explain your answer.

2. How might you redesign the groupings involved in this study to gain more potentially useful conclusions?

QUESTION 5. Scientific Research **Marks**

(a) You have studied at least two specific examples of scientific research programs based in Australia. **8**

(i) Write down the name of TWO projects, with a very brief summary of the aim(s) of the projects.

(ii) Choose ONE of the two projects in part (i). Write down its name.

(iii) Explain the scientific principles that underlie the project chosen in part (ii).

(iv) Describe how the research program was/is being carried out, paying special attention to the development of any new methods or techniques during the project.

(v) Describe how the scientific results coming from this project are being reported.

(vi) Explain whether the results from this project have led/may lead to conclusions that were totally unexpected at the beginning of the project.

(b) During this year you have carried out a scientific research project of your own and submitted a report of your findings. **6**

(i) Write down the name and the main aim(s) of your project.

(ii) Describe the design of your project, paying special attention to the variable(s) you studied and the relevance of any control(s) you may have included in your study.

(iii) State ONE significant conclusion you have made from your study. Describe how you reached this conclusion from your data or results.

(iv) Describe any future study or work that would provide greater information about your findings.

QUESTION 5. (Continued) **Marks**

(c) A school's swimming squad performed poorly at last year's swimming carnival. **6**

The swimming instructor randomly split the same squad into three groups to research techniques to improve performance.

The three groups are:

Group *A*. Normal training.

Group *B*. Normal training plus aquarobic exercise.

Group *C*. Normal training plus aquarobic exercise and meditation.

The three groups were tested after a reasonable time with the following results:

Group	*Training schedule*	*No. of swimmers*	*Previous year average times* 100 m (s)	*Present year average times* 100 m (s)
A	Normal	10	66·3	65·17
B	+ Aquarobic routine	9	66·2	61·5
C	+ Aquarobic routine + meditation	10	66·4	61·8

A statistical test shows that Groups *B* and *C* have performed significantly better than Group *A*, but there is no significant difference between Group *B* and Group *C*.

(i) Give TWO possible reasons for the better performance in all groups (*A*, *B*, and *C*) compared with last year's times.

(ii) Why did the instructor include a group that used the same coaching techniques as the year before?

(iii) Why did the instructor include Group *C* in the research design?

(iv) Does this evidence show that aquarobics improved performance, or are the significant improvements merely due to expectations raised in the special Groups *B* and *C*? Explain why.

QUESTION 6. Significant Technological Achievements **Marks**

This question must be answered in terms of a significant technological achievement drawn from the following list. **6**

Area	*Technological achievement*		
Agriculture	Farm implements	*or*	Genetic engineering in farm animals
Electronics	Integrated circuits	*or*	Use of fibre optics
Engineering	Pre-stressed structures and post-stressed structures	*or*	Refrigeration
Food	Milk products	*or*	Grape products
Manufacturing	Robotics in motor-car manufacturing	*or*	Assembly-line production of whitegoods
Materials science	PET	*or*	Solar cells
Textiles	'Superwash' wool	*or*	Shuttleless looms
Transport	Electric trains	*or*	Air-traffic control

(a) From the above list, select ONE technological achievement you have studied.

(i) Name the technological achievement. (Do not name the area.)

(ii) When you studied this technological achievement, you carried out experiments as part of your investigation. What was the aim of ONE experiment you conducted?

(iii) Describe the method you used to achieve your aim.

(iv) Name the variables you controlled in your experiment.

(v) Discuss your results and the conclusions you achieved.

QUESTION 6. (Continued) **Marks**

(b) From the above list, select ANOTHER technological achievement you have studied. **8**

(i) Name the technological achievement from a different area to that in part (a). (Do not name the area.)

(ii) Describe the advances in technology that led to the development of the achievement named in part (i).

(iii) Name the underlying technological principle(s) of the achievement(s) for both the present and its preceding technology.

(iv) What was the benefit in changing from one technology to the other?

(v) Discuss why research was carried out to move from the technology you named in part (ii) to the technology named in part (i).

(vi) 'Using any technology affects the society in which it is used.' Outline both a positive and a negative effect of using the technology you named in part (i).

(c) 'Without good design, no technology has ever been fully used.' **6**

(i) Choose ONE of the technologies you have studied and identify TWO of its design features.

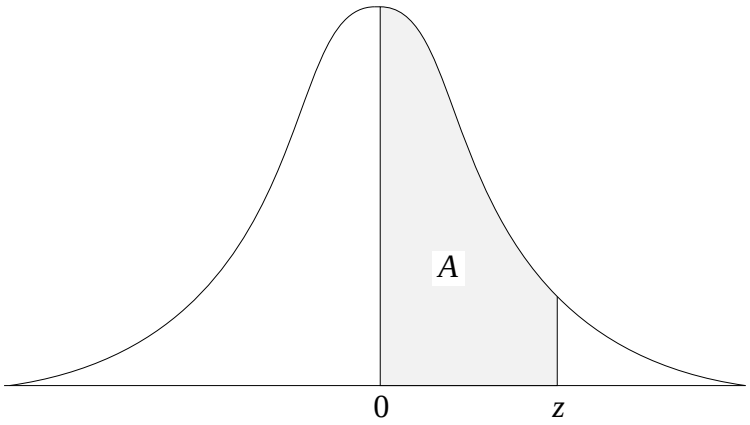
(ii) Outline TWO methods by which the technology has been developed to a marketable product.

(iii) Name TWO effects that the use of this product has had on society.

QUESTION 7. Statistical Methods **Marks**

(a) The examination marks in the subject Pure Studies are originally scaled so that they are approximately normal, with a mean of 50 and a standard deviation of 15 (but of course there can be no marks outside the range 0 to 100). **6**

GRAPH AND TABLE OF THE NORMAL DISTRIBUTION



z	A
0	0
1	0·34
2	0·475
2·5	0·495
3	0·5

(i) Draw a sketch of the distribution of marks in Pure Studies. Shade the region in which students scoring at least 87·5 marks lie, and find the percentage of students who score at least 87·5.

(ii) Following complaints, it is decided that the mean should be changed to 57·5. What percentage of students would then score at least 87·5?

(b) A survey of the wealth of 500 randomly selected Australians is undertaken. For this sample, the mean, median, mode, range, standard deviation, and inter-quartile range are calculated. **7**

Just before the results are to be distributed, it is discovered that the figure for the wealthiest person in the sample has been input wrongly. The correct figure is $1 million greater than the figure that was input.

(i) Which of the measures (mean, median, mode, range, standard deviation, and interquartile range) need to be recalculated? Explain your answer.

(ii) For those that do need to be recalculated, explain what the effect is. (Is it large or small? Does it increase or decrease the measure?)

(iii) The design for this survey involved randomly choosing 500 names from telephone books and ringing up the people whose names were chosen. Discuss the biases involved in this selection method.

QUESTION 7. (Continued) **Marks**

(c) You have undertaken a research project that used a survey to test a hypothesis. **7**

(i) State clearly the hypothesis that was being tested.

(ii) What considerations were taken into account in designing the survey? You may consider sample size, sampling techniques, choice of variables, duration or any other appropriate design features.

(iii) Describe the results briefly and discuss how well the results of the survey tested the hypothesis.

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QUESTION 8. Technology and the Consumer **Marks**

This question must be answered in terms of a consumer product drawn from the following list:

- Bicycle helmets
- Cameras
- Cosmetics
- Devices for heating water
- Fertilisers
- Hand-held, power-driven tools
- Household cleansers
- Irons
- Portable music-players
- Sewing-machines
- Types of household insulation.

(a) (i) From the above list, name ONE consumer product that you have *critically evaluated* in this course. **4**

(ii) Select TWO of the following product evaluation criteria:

- principles of operation
- environmental impact
- appropriateness for the function intended
- safety.

Discuss how you researched and compared brands/models in part (i), referring to these criteria.

(iii) Identify a target market group to promote *this* product into the marketplace. Give reasons for your answer.

(b) From the above list, name ONE consumer product you have evaluated in this course, different from the one named in part (a), and complete the following questions. **4**

(i) State ONE positive and ONE negative effect this product has had on society.

(ii) Describe ONE technological principle and ONE scientific principle underlying the operation of the product you have selected.

(c) (i) Discuss briefly why the *law* requires that at all times, consumers should be mindful of the expression 'caveat emptor', that is '*let the buyer beware*'. **4**

(ii) One role of advertising is to inform.

Name TWO other roles advertising may seek to perform.

Question 8 continues on page 18

QUESTION 8. (Continued) **Marks**

(d) Mobile phones, colds, and socks are all great mysteries! **8**

Mobile phones have joined the common cold, and what happens to your socks in the laundry, as some of the great mysteries faced by humankind. Many people are opting to buy mobile phones. However, the choices can be bewildering. Once a person is sure they want one, they need to clear some of the confusion.

A spokesperson for the industry watchdog Austel said consumers need to be aware of the following when selecting a mobile phone system.

- The digital mobile phone system will cover 80% of Australia by the end of 1996.
- The analogue mobile phone system will be phased out by 1 January 2000, because of government policy.
- Digital mobile phones tend to have enhanced quality and longer battery life.
- Digital mobile phones have an access card facility that will, under certain conditions, allow you to operate your handset overseas.
- Digital mobile phones can be hooked up to a number of related services, such as pagers, fax machines, answering machines, and computers.

QUESTION 8. (Continued) **Marks**

The specifications for three fictitious models of mobile phones are as follows:

	Duophone	*Superphone*	*Pocketphone*
Origin	Taiwan	Japan	Korea
Warranty (months)	12	24	12
Price	$550	$295	$375
Weight (g)	450	350	360
Battery capacity talk time (hours)	8	6	10
Dimensions (mm)	$190 \times 77 \times 32$	$170 \times 57 \times 22$	$150 \times 47 \times 12$
Transmitting power (W)	0·9 max.	0·7 max.	0·9 max.
Operating voltage (V)	7·2 (internal) 100 (household) 12 (car use)	7·2 (internal) 110 (household) 12 (car use)	7·2 (internal) 240 (household) 12 (car use)
Memory locations	100	150	100
Type	Digital	Analogue	Digital
Features	• Ease of use • Marathon battery • Safe battery disposal	• Office desk-top stand • Choice of colours	• Ease of use • Data card + cable • Safe battery disposal • Mobile charger

From the information and table provided, answer the following questions:

(i) Analyse the THREE model specifications. Based on the data provided and your analysis, select the *best* product. Give reasons for your answer.

(ii) Which model may offer the *least* benefit to a consumer? Give reasons for your answer.

(iii) What factors may influence a consumer to purchase the Superphone, even though the analogue mobile phone system is due to be phased out after 1 January 2000? Justify your answer.

(iv) Why do you think there are so many brands/models of mobile phones available to consumers?

QUESTION 9. Technology of Communication Systems **Marks**

(a) You have studied ONE of the following communications systems: **12**

- telephone
- radio
- TV
- computer networks.

(i) Draw a simple diagram of the system you studied, clearly labelling any specialised equipment used.

(ii) List and describe the encoding device, the decoding device, and the media of transmission for this system.

(iii) Explain what you would consider to be TWO limitations of the system you studied.

(iv) Describe the underlying scientific and technological principles that enable the technological system that you have studied to exist and work.

(v) Imagine that the communications system you have studied suddenly collapses and it no longer functions at all. Explain the implications of the system not working on:

1. yourself;

2. the wider community.

QUESTION 9. (Continued) **Marks**

(b) A family has been stranded on their farm by rising floodwaters. No regular communication is functioning. They cannot all be airlifted out, but they are in no immediate danger. **8**

There is a standard way, in this flood-prone district, to indicate the needs of the people to the helicopters providing emergency relief. They are to leave a signal, clearly marked, on the roof of the house:

- a large cross indicates that food is needed;
- a large circle indicates that there is a medical emergency.

If no symbol appears, no aid is needed.

AN EXAMPLE OF THIS COMMUNICATION SYSTEM BEING USED

(i) State why a community would devise this way of communicating?

(ii) Describe what the family might use to transmit their messages?

(iii) What would be the sources and effects of 'noise' or interference in the transmission of the message?

(iv) List TWO other limitations of this system.

(v) Briefly describe TWO different ways this emergency system has impacted on the local community.

QUESTION 10. The Environment **Marks**

(a) In 1995 an area of ice in Antarctica roughly the size of Tasmania suddenly broke loose from the mainland and floated out to sea. **8**

(i) Suggest a major consequence of this dramatic loss of ice-shelf from Antarctica.

(ii) Scientists in Antarctica have noted over the past fifty years a consistent upward trend in temperature. This trend parallels the rise in atmospheric carbon dioxide levels. Discuss how these two observations might be related.

(iii) Name ONE gas other than carbon dioxide that contributes to the greenhouse effect?

(iv) Discuss TWO major changes in human activity over the past fifty years that have caused the dramatic increase in greenhouse gases.

(v) Discuss ONE significant change to an individual's lifestyle that would contribute to a reduction of the level of greenhouse gases.

(vi) Discuss ONE significant political and/or social change that would contribute to reducing the level of greenhouse gases.

(b) Researchers at a rural university in Australia have isolated a range of soil bacteria. Some of these bacteria are particularly good at making bound phosphate available to plants, whereas others are capable of 'fixing' nitrogen from the air and making this available to plants. These researchers aim to produce a stable mixture of bacteria that can be used in agriculture. **6**

(i) Suggest TWO possible benefits such research may contribute to Australian agriculture.

(ii) The researchers are part of a worldwide network of people working towards 'sustainable' agriculture. Discuss the meaning of this term, relating it to soil erosion, and soil salination.

(iii) Another group of researchers at the same university has isolated a bacterial gene that gives the genetic code for the production of a powerful naturally occurring pesticide. They have succeeded in introducing this gene into cells of the cotton plant. Discuss ONE possible positive outcome and ONE possible negative outcome of this research.

QUESTION 10. (Continued) **Marks**

(c) You have undertaken research, and prepared an environmental report, on an issue of local significance. **6**

(i) What was the issue of local significance that you investigated?

(ii) Describe TWO major methods you used to address your local issue.

(iii) Describe your conclusions and any recommendations you would make to improve the situation.

(iv) Discuss how these conclusions/recommendations might impact on the political and/or economic life of your community.

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