



**HIGHER SCHOOL CERTIFICATE EXAMINATION**

**1997**

# **APPLIED STUDIES**

**1 UNIT**

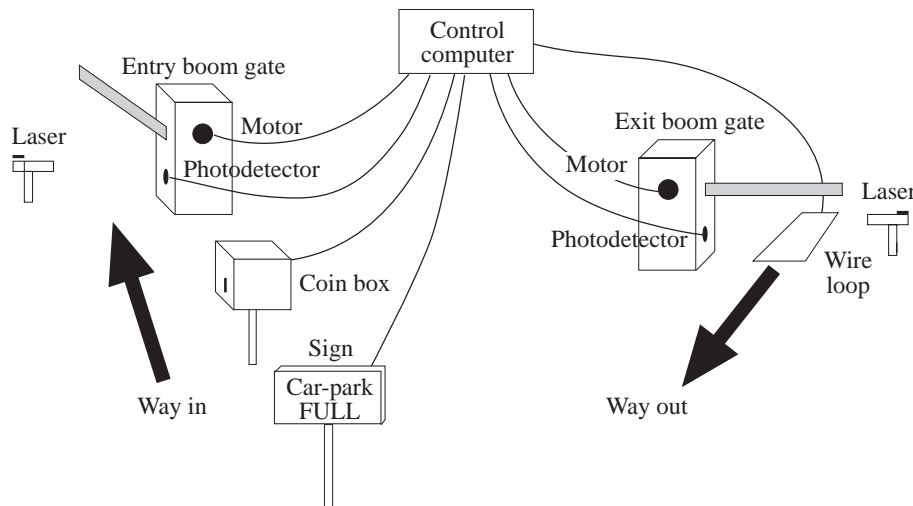
*Time allowed—Two hours  
(Plus 5 minutes reading time)*

**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 commercial car-parking station has replaced the security guard and toll collector with the computer-controlled system shown below. **12**



With this system, cars approach the entrance and the driver inserts a \$2 coin into the coin box. The boom is raised by an electric motor and the car can then proceed through to the car-park. As it passes the gate, the car breaks a light beam that is sent from the laser to a photodetector mounted under the boom.

To leave the car-park, cars approach the exit boom gate and drive over a wire loop embedded in the road. This wire loop signals the presence of large amounts of metal above it. The exit gate also has a laser and photodetector system like the entry gate.

When there are no free parking spaces, the car-park full sign is lit up.

The connections of the main systems to the control computer are shown in the above diagram.

Parts (i) to (iv) are multiple-choice questions. Select the alternative A, B, C, or D that best answers the question and write it next to the question number in your Writing Booklet.

- (i) In this computer-controlled system for the parking station, an example of an effector (or actuator) is the
- (A) coin box.
  - (B) car-park full sign.
  - (C) wire loop at exit.
  - (D) laser.

## QUESTION 1. (Continued)

**Marks**

- (ii) An example of a feedback loop in this system is
- (A) coin box, control computer, entry boom gate, motor.
  - (B) laser, photodetector, control computer.
  - (C) wire loop.
  - (D) none of the above.
- (iii) If the entry boom gate jammed in the open (raised) position, and cars entered without drivers inserting a \$2 coin, it is likely that
- (A) there would be no effect on the operation of the system.
  - (B) the car-park full sign may not light up at the correct time.
  - (C) the exit boom gate would also remain open.
  - (D) the exit boom gate would remain closed.
- (iv) If the car-park were extended to hold double the number of cars, which part of the computer-controlled gate system would have to be changed for it to work in the same way as before?
- (A) The computer program running on the control computer.
  - (B) Wiring of the car-park full sign.
  - (C) The coin box, to allow a driver to insert a single \$1 coin.
  - (D) Adding a second photodetector at the entry gate.

Parts (v) to (viii) are short-answer questions also related to this computer-controlled car-park system.

- (v) Suggest the most likely purpose of the photodetector and laser at the gates. How could you test whether your suggestion was correct without following the wiring in detail or looking at the program running on the control computer?
- (vi) The boom gate motors burn out regularly because they stay on, even when the boom is fully raised or fully lowered. Carefully describe how the system could be modified to solve this problem.
- (vii) Write an algorithm, or draw a flowchart, that shows how the part of the computer program controlling the car-park full sign would work.
- (viii) Discuss briefly the social implications of the introduction of this computer-controlled car-park system.

## QUESTION 1. (Continued)

**Marks**

- (b) In your course, you have studied a number of 'real world' computer-controlled systems. Choose one of these (not the system in part (a) above) and answer the following questions. **8**
- (i) Name the system and describe its overall function.
  - (ii) Draw a labelled block diagram of the main components.
  - (iii) List the sensors and actuators in the system.
  - (iv) Give ONE reason for the introduction of the system.
  - (v) Discuss the social and ethical issues that have resulted from the introduction and use of this system.

**QUESTION 2. Applied Mathematical Skills****Marks**

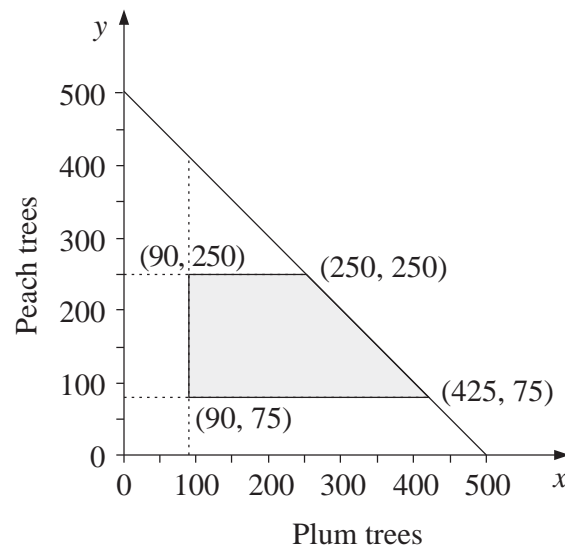
- (a) A farmer plans to increase the number of fruit trees on an orchard to maximise profit. At present there are 90 plum trees and 75 peach trees and each tree is capable of producing exactly one box of fruit. The orchard has the capacity to grow 500 trees in total but the farmer decides that there will be no more than 250 peach trees. **6**

The profit made on each box of plums is \$2.50 and on each box of peaches \$3.25.

The graph below was used to find the maximum profit that could be made:

$x$  represents the number of plum trees.

$y$  represents the number of peach trees.



- (i) Write down the equation in terms of  $x$  and  $y$  for the profit ( $P$ ).
- (ii) What is the maximum profit that can be made under the given constraints? Show all necessary working.
- (iii) What is the increase in profit that would be made by expanding the orchard from its initial capacity to make this maximum profit?

## QUESTION 2. (Continued)

Marks

- (b) At a major sporting event, a system for serving one cup of soft drink to each spectator quickly and efficiently was trialled. The system used three machines, each dispensing soft drink into a different sized cup. See the table below. **4**

	<i>Size of cup</i>	<i>Number of cups served per minute</i>
Machine 1	Large	5
Machine 2	Regular	8
Machine 3	Small	12

Queues were formed so that each machine started with twenty-five spectators. Then four spectators joined each queue every minute.

- (i) How many spectators were served *either* small *or* large sized soft drinks in the first four minutes?
- (ii) How long was it before the queue for regular sized soft drinks was empty? Show all necessary working.
- (c) A 1992 newspaper article suggested that the kangaroo population in northern NSW would be five times larger by 1997. **6**

An independent study predicted that the kangaroo population in northern NSW could be modelled using the equation below, where time  $T$  is measured in years since 1992 and  $N$  is the number of kangaroos in thousands.

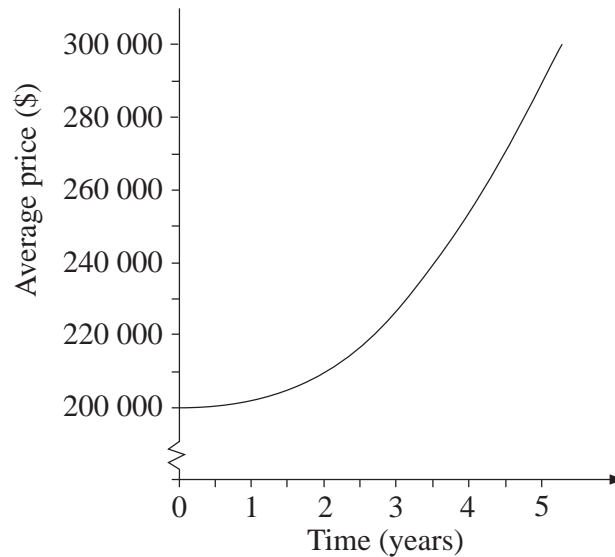
$$N = 17.3e^{0.28T}$$

- (i) What type of population growth is described by the above equation? Describe the features of this type of population growth.
- (ii) Calculate the expected population of kangaroos for 1997 using this model. Show all necessary working.
- (iii) Use your answer from part (ii) to show whether the results of the model DO or DO NOT support the claim of the newspaper article. Give reasons.

## QUESTION 2. (Continued)

**Marks**

- (d) Average house prices in many Sydney suburbs have increased considerably over the past five years. Figures from leading real-estate groups were collated. See the graph below. **1**



Using the graph, estimate the average price of a house in Sydney after the first four years.

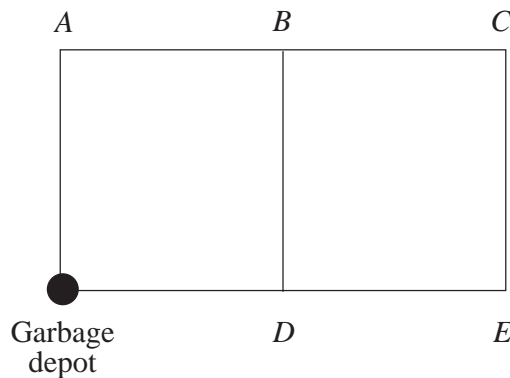
- (e) The price of a home unit was seen to follow the compound interest formula **3**

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

This home unit was valued at \$150 000 after three years. If the compound interest rate was 6% per year, use the formula above to find the original price of the home unit. Show all necessary working.

**QUESTION 3. Mathematical Ideas****Marks**

- (a) (i) What is the main difference between Copernicus' and Ptolemy's models of the solar system? **4**
- (ii) What was the main improvement that Kepler made to Copernicus' model?
- (iii) Draw a diagram of Kepler's model of the solar system, showing only the Sun, Earth, Mars, and their orbits.
- (b) (i) Explain what it means to say that a number is rational. **5**
- (ii) Is  $3\frac{1}{7}$  rational? Explain your answer.
- (iii) Is  $3\frac{1}{7}$  less than, greater than, or equal to  $\pi$ ? Give any necessary working.
- (c) A garbage pickup route must cover all of the following network of streets. It must begin and end at the garbage depot. **6**



- (i) Explain briefly why it is impossible to design a route that covers each street only once.
- (ii) Describe a route (by listing the corners in the order in which they are visited) so that only one street is travelled twice.
- (iii) Is this route the shortest way for pickups to be made? Explain your answer.



## QUESTION 3. (Continued)

Marks

- (d) One of Euclid's axioms states:

5

'It is possible to draw a circle with any point as the centre and with any radius.'

In the first theorem that he derives from his axioms, Euclid draws a line  $AB$ , as follows:



and applies this axiom twice, using  $A$  and  $B$  as the centres of circles, and using  $AB$  as the radius in both cases.

- (i) Draw the resulting diagram.
- (ii) The two circles in the diagram intersect (cross each other) at two points. Label these  $C$  and  $D$  on your diagram.
- (iii) Is the length  $AC$  less than, greater than, or equal to, the length  $AB$ ? Explain your answer.

**QUESTION 4. Science and Medicine****Marks**

- (a) (i) Name a medical diagnostic technique you have studied this year. Write a brief account of the development of this technique from basic scientific principles to widespread medical application. **6**
- (ii) Comment on any adverse effects this technique may have on the body.
- (iii) An alternative diagnostic procedure is claimed to achieve similar results, with no such adverse effects as you have described in part (a) (ii). List the criteria that would be important in judging this claim.
- (b) Choose ONE case study from the following list: **6**
- asthma
  - anaemia
  - diabetes
  - malaria
  - smallpox
  - tuberculosis.

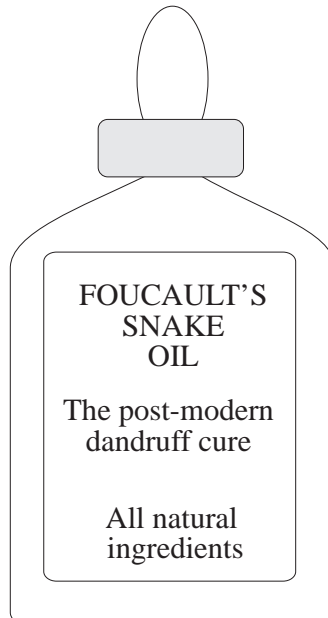
For the condition you have chosen:

- (i) Describe how detailed observation identified the factor(s) contributing to this condition.
- (ii) Describe TWO signs or symptoms characteristic of this condition.
- (iii) Explain how the identification of the contributing factors in part (b) (i) led to the development of *effective* treatments for this condition.
- (iv) Briefly describe one testing procedure used to ensure the effectiveness of treatment.
- (v) In the light of your answer to part (b) (iv), explain how treatment procedures have improved over the years.

## QUESTION 4. (Continued)

Marks

- (c) You have a bad case of dandruff. A friend advises you against using harmful chemicals on your hair and gives you a bottle of Foucault's Snake Oil. You apply this daily for a week with no apparent effect. 8



- (i) You plan to scientifically test the effectiveness of Foucault's Snake Oil as an anti-dandruff agent. Describe TWO ways in which you could incorporate suitable controls.
- (ii) Your beliefs about Foucault's Snake Oil may influence your findings.
1. Explain why this might occur.
  2. How would you design your test so that your beliefs do not influence the results?
  3. What is this general procedure called?
- (iii) Why is it desirable to repeat the experiment for:
1. different people?
  2. different lengths of treatment?

**QUESTION 5. Scientific Research****Marks**

- (a) You have studied at least two specific examples in the following list of Australian research programs. **7**
- A project associated with CSIRO's Australia telescope
  - Antarctic research projects involving ice-core studies
  - The bush fly control program
  - The crown of thorns starfish research project
  - Gene mapping and/or transgenic animals
  - Methods of assessing and monitoring corrosion
  - Studies involving health and food additives
  - The Synroc project
  - A sewage treatment project
  - A project to develop alternative energy sources
- (i) 1. Write down the name of TWO projects. Write a brief statement of the problem(s) being investigated for each of the two projects.
2. Describe ONE procedure of scientific research that was applied in each of the projects. Give the specific way the procedure was applied in each project.
- (ii) 1. Choose ONE of the two projects in part (a) (i). Write down the name of this project.
2. State ONE reason for the design of the research program.
3. Describe ONE result from the project.
4. Discuss how this result may be applied to solving the problem that was researched by this program.
- (b) During this course you have carried out a scientific research project of your own and submitted a report of your findings. **6**
- (i) Write down the aim of your project.
- (ii) Describe how you designed your investigation so as to obtain reliable results.
- (iii) Describe how your review of relevant literature influenced the design of your investigation.
- (iv) Describe how the conclusion(s) from your investigation provided information on the problem under investigation. State at least ONE significant conclusion from your investigation.

## QUESTION 5. (Continued)

**Marks**

- (c) A secondary school community is concerned about the poor quality and design of some school backpacks used by students. The school is unable to provide lockers and desks in which to store their books and materials, and students carry their backpacks around all day. **7**

You have been asked to design a scientific investigation of the quality and design of five school backpacks on the market. The prices of the five backpacks are comparable and are not an issue. The colour of all five backpacks is navy blue.

- (i) List TWO characteristics a good quality well-designed backpack might have. (Do not discuss personal taste.) State why each characteristic is important.
- (ii) Describe briefly the design of the investigation that you would use to determine the best backpack. Include in this description:
  - any variables;
  - any controls;
  - methods of ensuring reliability of the results.
- (iii) Write down TWO questions you might want answered from the review of relevant literature.

**QUESTION 6. Significant Technological Achievements****Marks**

This question must be answered in terms of significant technological achievements from the following list.

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

- (a) (i) What is meant by the term 'technological achievement'? **4**
- (ii) Describe a practical experience that was related to a technological achievement you have studied.
- (iii) Explain how this practical experience improved the understanding of the the achievement.
- (b) Select ONE technological achievement from the above list. **6**
- (i) Name the achievement.
- (ii) Describe the basic principles of operation of this achievement.
- (iii) Describe how this achievement was implemented.
- (iv) Describe TWO improvements that could be made to this technology in the future.
- (c) Select ANOTHER technological achievement from the above list. **4**
- (i) Name the achievement.
- (ii) Describe the technology available in this area immediately before the breakthrough of this achievement.
- (iii) Explain why the new technology replaced the old technology.
- (iv) Describe ONE positive and ONE negative effect of this achievement.

## QUESTION 6. (Continued)

**Marks**

- (d) 'Technology arises because there is a need to be filled.'

**6**

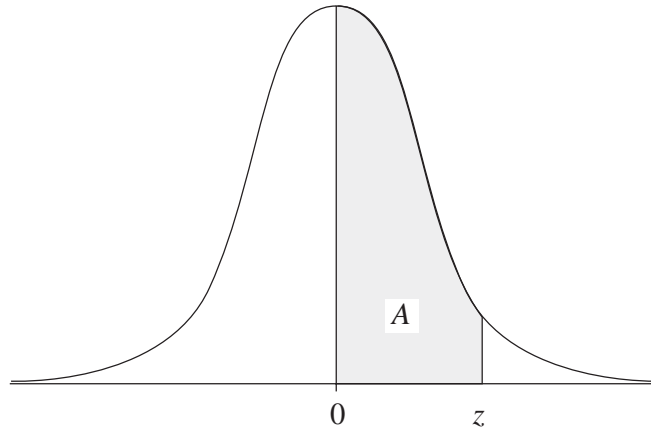
Referring to TWO achievements you have studied, answer the following questions.

- (i) For EACH achievement, state whether the above quote *matches* or *fails to match* what you know about the technology, and give reasons for your choice.
- (ii) Which of these two achievements would have had the greater impact on society? Give TWO reasons for your choice.
- (iii) Which of the two achievements would have had a greater impact on production? Give TWO reasons for your choice.

**QUESTION 7. Statistical Methods****Marks**

- (a) A busy Sydney police station recorded the number of phone calls it received every day during a 200-day period. The results were normally distributed with a mean of 120 and a standard deviation of 12. **5**

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) Sketch the normal distribution of the number of calls at the police station.

State the numbers of calls that correspond to the  $z$ -scores  $-1, 0, 1$ . Mark these on your sketch.

- (ii) On how many days during the study would you expect that over 132 calls were received?



## QUESTION 7. (Continued)

Marks

- (b) At an international conference on developing countries, participants are provided with a table giving the population and the average weekly earnings per head for each of the world's nearly 200 countries. 8

Representatives of the Association of Post-Colonialist Atolls want aid. They claim that the figures show 'Most countries are poor and with low populations'. In response, representatives of the Big Twelve, the world's largest countries, claim that the figures show 'Most of the world's people live in populous and relatively rich countries'.

- (i) Can these claims both be true? If so, explain the apparent conflict. If not, explain which is more likely to be false.
- (ii) It is proposed that the ten countries with the smallest populations come together to form a single country.
1. Would this increase, decrease, or leave unaffected the median population of all countries? Explain your answer.
  2. Would this increase, decrease, or leave unaffected the average population? Explain your answer.
  3. Would this change the range of populations? Explain your answer.
- (c) A welfare lobby group decides to conduct a survey of community opinion on 'work for the dole' schemes. To ensure a range of opinion, twenty people are randomly chosen from each of the following four groups: 7
- Year-12 students at a local high school;
  - unemployed people at a local CES office;
  - Sydney barristers;
  - talkback radio callers on a city radio station.

It is found that 70% of those surveyed strongly support the concept of 'work for the dole' schemes.

- (i) Explain what is meant by the term 'bias'.
- (ii) Is the survey figure of 70% a reliable measure of community support for 'work for the dole' schemes? Explain your answer, discussing any likely sources of unreliability.
- (iii) The sample size could be increased to 300 people in each of the four groups. Would this be a good method of increasing the reliability of the survey? Explain your answer.
- (iv) How would you improve the design of the survey to remove the sources of unreliability that you identified in part (ii)?

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

This question must be answered in terms of the consumer products 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) Name ONE product or category from the above list. **6**
- (ii) Describe how this product works.
- (iii) What is the product's main energy source, if any?
- (iv) What materials are used to make the product?
- (v) Describe TWO factors, other than cost, you would use to determine the *best* buy.
- (b) From the above list, select ANOTHER product or category. **8**
- (i) Name this product or category.
- (ii) How has society benefited from the use of this product?
- (iii) Give TWO effects this product has had on the environment.
- (iv) Give ONE safety feature that has been incorporated into this product.
- (v) Give TWO ways a consumer can influence the further development of the product.
- (vi) You want to find out if the product is appropriate for the function intended. Describe a test you could perform and indicate what you would measure to show that the product is appropriate.

## QUESTION 8. (Continued)

Marks

- (c) Sports drinks have become increasingly popular since the 1960s in Australia. **6**

Sports drinks are designed to provide fluids to prevent dehydration, and carbohydrates to replace lost energy during and after exercise.

A concentration of carbohydrates between 5% and 10% is easily absorbed by the body. Lower levels do not top up blood sugar, and higher levels, above 10%, take longer for the body to absorb.

Sports drinks contain a variety of sugars, flavours, colours and sodium. Sodium assists in the faster absorption of fluids. Sugar levels are lower in sports drinks than in soft drinks.

Sports drinks are sold in either powder or liquid form.

Marketing strategies have changed over the last few years. Advertisements no longer just target athletes in training but also health-and-lifestyle-conscious people, especially teenagers and children. Television commercials often feature famous athletes promoting a certain drink.

The table below provides information on a number of different brands.

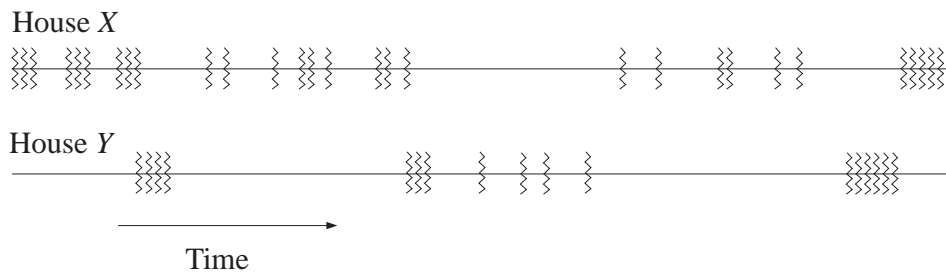
<i>Product</i>	<i>Type</i>	<i>Origin</i>	<i>% carbohydrate</i>	<i>Cost per serve</i>
<i>A</i>	Powder	Australia	7.1	\$0.40
<i>B</i>	Liquid	New Zealand	13.5	\$1.12
<i>C</i>	Powder	USA	7.4	\$0.12
<i>D</i>	Liquid	Australia	6.5	\$1.30
<i>E</i>	Liquid	Australia	4	\$1.30

- (i) Which product would you choose to buy? Give TWO reasons for your choice.
- (ii) Give ONE possible reason why consumers would purchase a sports drink in liquid form rather than powder form.
- (iii) Why have manufacturers of sports drinks changed their marketing strategies over the last few years?
- (iv) Sports drinks are often sold in school canteens. Give ONE reason *for*, and ONE reason *against*, school canteens selling sports drinks.

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

- (a) Neighbours in nearby houses (*X* and *Y*) decide to set up their own communication system. They connect wires between their two houses with a buzzer and switch at each end. When the switch is pushed in one house, the buzzer sounds in the other house. **6**

Messages are conveyed by a code using a series of buzzes. A sample of some communication between the neighbours is represented in the diagram below. Each mark represents a short 'buzz' sound made at that house.



KEY

⋈ Buzz

- (i) Name one fundamental principle of communication.
- (ii) State TWO advantages of this communication system.
- (iii)
  1. State TWO disadvantages of this communication system.
  2. Suggest a method of eliminating one of the disadvantages you have identified.

## QUESTION 9. (Continued)

**Marks**

(b) Select one of the communication systems below:

**14**

- Telephone
  - Television
  - Radio
  - Computer networks.
- (i) Name the system you have studied. The rest of this question must be answered in terms of the communication system you have chosen.
  - (ii) How did this communication system develop? Mention TWO of the needs that gave rise to it.
  - (iii) State ONE OTHER application of the system that is different from its original purpose.
  - (iv) Draw and label the main parts of the communication system.
  - (v) Explain how the coding and decoding works in the system.
  - (vi) In what form is the information transmitted?
  - (vii) Name TWO sources of noise in this system.
  - (viii) What effect does noise have on the transmitted information?
  - (ix) Apart from noise, discuss ONE OTHER limitation of the system.

**QUESTION 10. The Environment****Marks**

- (a) Parts (i) to (iv) are multiple-choice questions. Select the alternative A, B, C, or D that best answers the question and write it next to the question number in your Writing Booklet. **4**
- (i) The greenhouse effect is a phrase used to describe
- (A) holes in the ozone layer that cause global warming.
  - (B) global warming caused largely by an increase in atmospheric carbon dioxide levels.
  - (C) climatic change caused by gradual warming of the polar icecaps.
  - (D) increased sun cancers caused by an increase in ultraviolet radiation.
- (ii) Refrigerant gases such as chlorofluorocarbons (CFCs) are responsible for depletion of a protective gas in the upper atmosphere because
- (A) they are unnatural.
  - (B) they release carbon dioxide as they react with ozone.
  - (C) they enter into a destructive reaction cycle with ozone.
  - (D) they release ultraviolet radiation which reacts with ozone.
- (iii) Widespread use of pesticides in agriculture poses a major environmental problem because
- (A) organophosphates are a significant cause of ozone depletion.
  - (B) pesticides cause the water table to rise.
  - (C) chlorinated hydrocarbons accumulate in the food chain.
  - (D) pesticide runoff encourages growth of algal bloom in rivers.
- (iv) One of the main causes of soil salination is
- (A) overuse of pesticides.
  - (B) deforestation.
  - (C) overuse of fertilisers.
  - (D) open-cut mining.

## QUESTION 10. (Continued)

Marks

- (b) You have investigated a LOCAL PROBLEM of particular environmental concern to your community. 10
- (i) Briefly describe the environmental issue of local significance that you investigated.
  - (ii) How did *you* become aware of this problem? Comment on the general level of awareness of this problem in your local community.
  - (iii) Discuss the research methodology employed in your investigation and suggest an alternative methodology you might employ in a future investigation of the same problem.
  - (iv) Explain how the results of your investigation might lead to a solution to *all or part* of your local problem.
  - (v) Explain how the local issue you investigated is related to other, more global issues.
  - (vi) ‘One person’s problem is another’s opportunity.’  
Discuss ONE way in which an ecological solution to your local problem may contribute positively to your local economy.
  - (vii) You have been co-opted by your local council onto a committee whose job is to increase local awareness *of* and to increase community responsibility *for* your local environmental problem. Outline a plan of an effective public education campaign you might coordinate.
- (c) From 1970 to 1985 the water engineers in a small country town added fluoride to the town water supply to protect children from tooth decay. Following an outcry from a group of citizens concerned that fluoridation might cause cancer, the practice was discontinued in 1986. Health statistics published in 1996 showed a highly significant continuous increase in tooth decay in ten-year-old children in the years 1987 to 1995. The statistics also showed a highly significant overall decline in lung cancer in the general population over the same period. 6
- (i) Do you think this evidence points to a connection between fluoridation and cancer? Explain your answer.
  - (ii) Further information shows that though there has been an overall decline in lung cancer in the town, there has actually been a significant *increase* in lung cancer in farm workers in the surrounding rural districts. They all use the same water supply as the town.
    1. Discuss TWO possible causes for the different distribution of lung cancer between farm workers and town dwellers.
    2. Discuss what further information you might need to discriminate between these possible causes.

BLANK PAGE