

B O A R D O F S T U D I E S
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

1999

APPLIED STUDIES

1 UNIT

*Time allowed—2 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) The article below describes a cruise control system for a motorcycle. It comes direct from the manufacturer's publicity information. 8

Easy Rider



The *Easy Rider* Cruise Control operates by monitoring the road speed of the bike and uses a computer to operate the bike's brakes and throttle (accelerator) to maintain the speed which has been set by the rider.

The computer is instantly de-activated by either front or rear brake levers. When the rider presses the resume button the bike smoothly accelerates to its previously set speed.

The *Easy Rider* Cruise Control

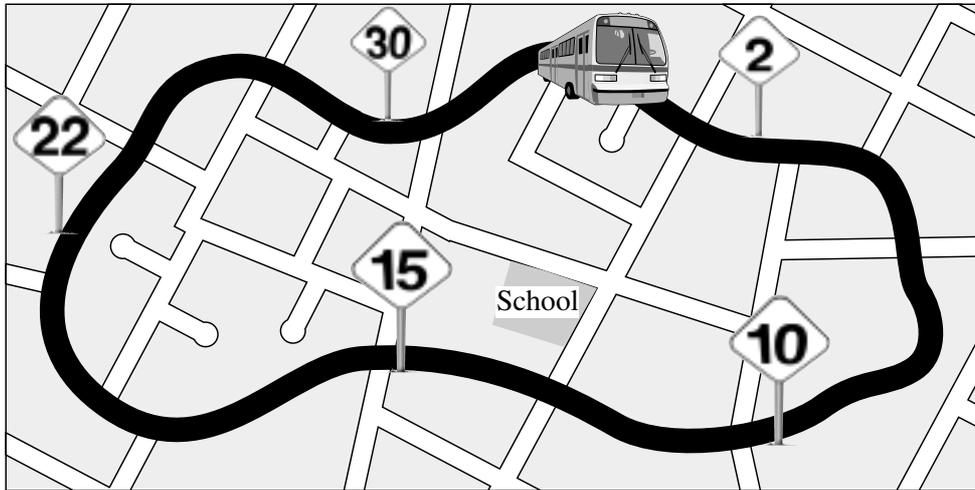
- substantially reduces the risk of being booked in suburban areas and in highway riding.
- reduces stress and fatigue on long trips.
- lets you arrive at your destination more relaxed than ever before.
- significantly improves fuel consumption.

- (i) Describe the functions of TWO sensors that are present in the cruise control system.
- (ii) Describe the functions of TWO actuators that are present in the cruise control system.
- (iii) Is the system, as described, an open loop feedback control system or a closed loop feedback control system? Give reasons for your choice of classification for the system.
- (iv) Discuss ONE social implication that might arise from the use of such a cruise control system.

QUESTION 1 (Continued)

Marks

- (b) The diagram below shows a messaging system for passengers awaiting the arrival of the bus in a small town. 6



The bus continuously travels the loop road as shown above. There are five bus stops in the route. At each bus stop a sign displays the expected arrival time, in minutes, of the bus. The position of the bus is monitored by sensors at each stop and this information is sent to a central computer which computes the times for display on the signs.

- (i) Describe an algorithm that would need to be implemented in the central computer in order to calculate the expected arrival times.
 - (ii) What are TWO advantages of using such a system?
 - (iii) Suggest TWO ways the system can be changed to make the predictions of time more accurate.
- (c) Choose one working model of a computer-controlled system you have assembled. Do NOT use the systems described in either part (a) or part (b). 6
- (i) Name the system.
 - (ii) Discuss the needs and conditions that gave rise to the system you studied.
 - (iii) Draw and label a block diagram of the system. On the diagram, identify ONE sensor and ONE actuator (effector).
 - (iv) Describe the principles behind the working of the sensor and the actuator (effector) identified in part (iii).
 - (v) Discuss ONE implication, to the real world, of the use of systems such as the one you have assembled.

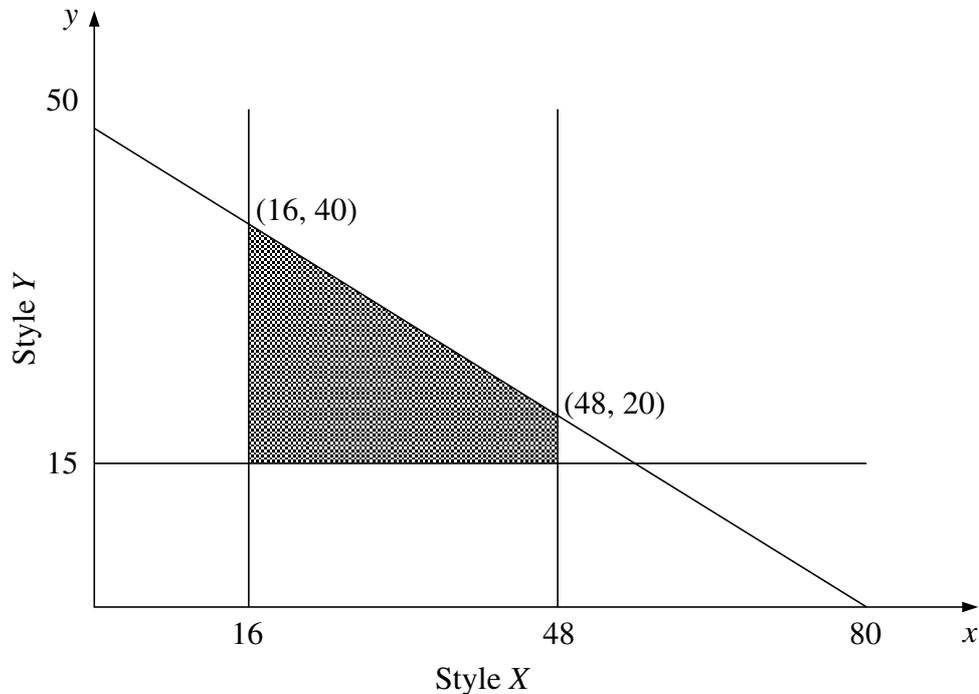
QUESTION 2 Applied Mathematical Skills**Marks**

- (a) A small manufacturing company specialises in the production of two styles of frames designed to hold filters for air-conditioner units. **5**

A profit of \$17 is made on each unit of Style X. A maximum of 80 units can be made if all resources are committed to production of Style X. Existing contracts require the daily production of 16 units. Limited market demand has resulted in a management decision to cap production of Style X at 48 units per day.

A profit of \$24 is made on each unit of Style Y and, if all the company's resources are devoted to this style, no more than 50 units can be produced in a single working day. Existing contracts require that a minimum of 15 units be produced each day.

The graph below can be used to find the profit associated with the production of the two styles of frames.



- Write down the equation in terms of x and y for the profit (P).
- What is the maximum profit that can be made under the given constraints? Show all necessary working.
- The company decides to have a maintenance day. On this day, production is restricted to the minimum production levels. What profit will the manufacturing company earn on the maintenance day?

QUESTION 2 (Continued)

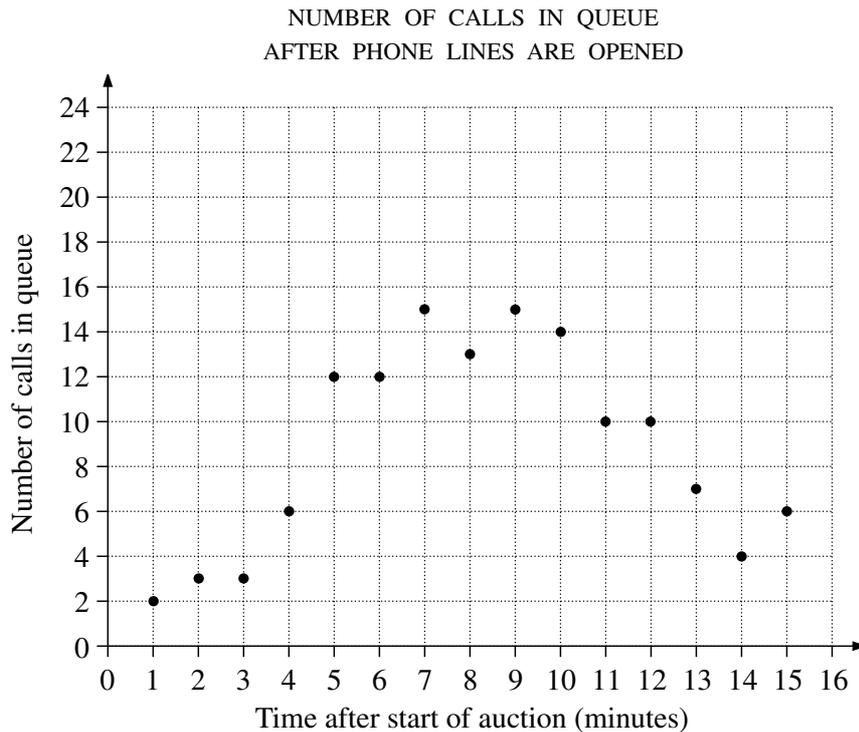
Marks

- (b) A radio station conducts a call-in radio auction for a local charity.

6

When a call is made it is acknowledged and placed in a queue. Some time later, the call is answered by an operator and the bid is taken.

The radio station monitors the number of calls in the queue at one minute intervals. This is shown in the graph below.



- (i) How many phone calls were in the queue 3 minutes after the phone lines had been opened?
- (ii) What was the increase in the number of calls in the queue between 4 and 5 minutes?
- (iii) Give TWO reasons that might explain what happened to the number of calls in the queue between 7 and 9 minutes.
- (iv) The number of calls in the queue was the same at 11 and 12 minutes. Give TWO reasons that may explain this.

Question 2 continues on page 6

QUESTION 2 (Continued)

Marks

- (c) A country has an annual inflation rate of 50%. It is expected that this rate of inflation will continue unchanged. The price of goods can be calculated using the formula **5**

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

where A is the price after n years

P is the original price

r is the annual rate of inflation

n is the number of years.

- (i) A CD currently costs \$29.50 in this country. After ONE year it will cost \$44.25.

What will it cost, to the nearest cent, after:

1 two years?

2 three years?

- (ii) Graph the results from part (i), putting time (Year 1, Year 2, Year 3) on the horizontal axis and cost on the vertical axis.
- (iii) Using the graph in part (ii), discuss the nature of the increase in the cost of the CD.

- (d) (i) State ONE of the underlying principles of the Malthusian Law of Population Growth. **4**
- (ii) State ONE of the underlying principles of the Logistic Law of Population Growth.
- (iii) Explain why the Malthusian Law and the Logistic Law of Population Growth only explain population changes under ideal circumstances.

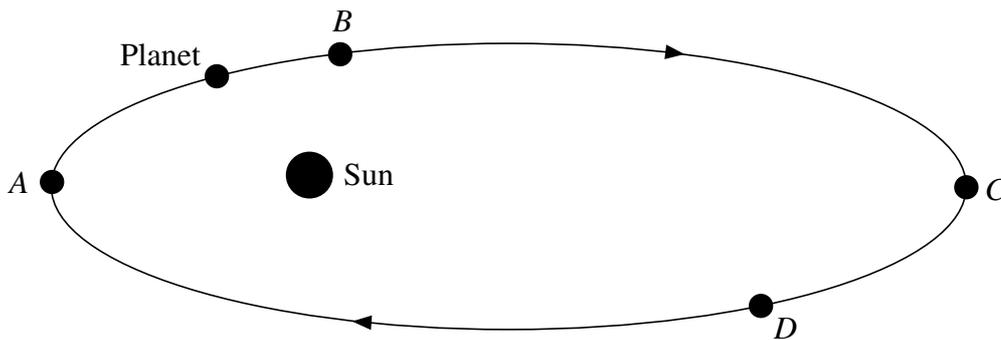
QUESTION 3 Mathematical Ideas**Marks**

- (a) Plato's model of the solar system (Plato, 400 BC) fixed the Earth at the centre. The celestial bodies: Moon, Sun, Venus, Mercury, Mars, Jupiter and Saturn, were placed in order of distance from the Earth. It was believed that these celestial bodies orbited the Earth in circular paths. **4**

- (i) Draw a sketch of Plato's model of the solar system. Label your diagram.
- (ii) Give ONE reason why the Moon was placed closer to the Earth than the Sun in Plato's model.
- (iii) Compare and contrast the solar system models of Plato and Copernicus.

- (b) Kepler (1571–1630) established that all planets move in elliptical orbits. **3**

The diagram below shows the path of a planet about its sun. The four points *A*, *B*, *C* and *D* are positions in the orbit of the planet.



- (i) What word is used to describe the position of the sun?
- (ii) At which point, *A*, *B*, *C* or *D*, is the planet moving slowest? Explain your answer.

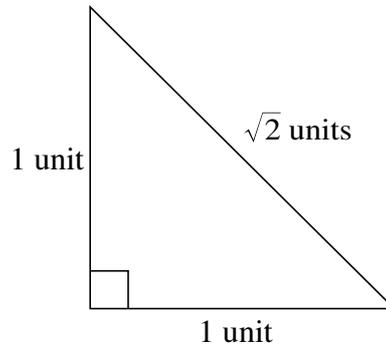
Question 3 continues on page 8

QUESTION 3 (Continued)

Marks

- (c) The Pythagoreans (Pythagoras, 530 BC) knew that a right-angled isosceles triangle with sides of length 1 unit had a hypotenuse of length $\sqrt{2}$ units. This is shown in the diagram below.

6



- (i) Inscribe a square in a circle of radius 1 unit and hence deduce that

$$\pi > 2\sqrt{2}.$$

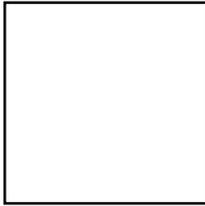
- (ii) Explain why inscribing an octagon in a circle would give a better approximation of π than that found in part (i).
- (iii) What would be the dimensions of a square in which the circle in part (i) could be inscribed?
- (iv) A recent approximation of π was found to be accurate to millions of decimal places. Give an example of a practical situation where this degree of accuracy is necessary.

QUESTION 3 (Continued)

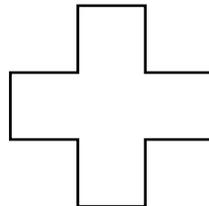
Marks

- (d) The first three steps in the construction of a fractal pattern based on squares are drawn below. 4

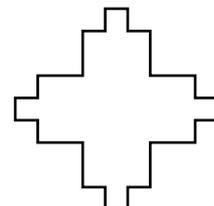
Original shape



Stage 1



Stage 2



- (i) Describe how the next stage (Stage 3) in the pattern would be generated.
- (ii) The area of each stage in the generation of a fractal is given by the formula

$$A_n = A_{n-1} - 2^{n+1} \left(\frac{S}{3^n} \right)^2$$

- where n is the stage of fractal generation
 S is the length of sides of the original shape
 A_n is the area of the fractal at stage n
 A_{n-1} is the area of the fractal at stage $(n - 1)$
 A_o is the area of the original shape.

Given that $S = 9$ cm, calculate the area of the fractal at Stage 2.

- (e) (i) In Euclidean geometry, what is an axiom? 3
- (ii) Give an example of an axiom which, while true in Euclidean geometry, is NOT true in non-Euclidean geometry. Give sufficient detail to explain your answer.

QUESTION 4 Science and Medicine**Marks**(a) Diagnostic techniques routinely used in medical practice include: **8**

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

- (i) Name the technique you have studied in detail.
- (ii) Describe how an understanding of basic scientific principles led to the development of this technique.
- (iii) Explain how and why the range of applications of this technique has grown from its introduction to the present day.
- (iv) Give ONE advantage and ONE limitation of this technique.
- (v) A doctor claims to be able to match the diagnostic value of this technique much more cheaply.

Discuss TWO ways you could investigate the doctor's claim.

(b) Choose ONE case study from the following list: **7**

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

- (i) Name the medical condition you have studied.
- (ii) Describe how careful observation or experimentation led to the identification of the factor(s) contributing to this condition.
- (iii) Briefly trace the history of the development and testing of effective and safe pharmaceuticals for this condition.
- (iv) An advertisement has appeared in your local newspaper claiming an effective, ecologically sensitive, natural herbal remedy for the treatment of the condition you have chosen.

1 Some market research reveals skyrocketing sales. Why do you suppose people buy this product in the absence of any credible testing?

2 You decide to examine the claims made for the herbal remedy. Outline TWO crucial aspects of the design of a suitable trial.

QUESTION 4 (Continued)

Marks

- (c) A large-scale trial was conducted on a new drug claimed to be effective against hay fever. Six thousand people were split into three groups (*A*, *B* and *C*). Each group received different treatment. Each person was asked to report severe hay fever symptoms prior to the treatment, for three weeks while receiving the treatment, and for one week after treatment. 5

The results appear in the table below.

PERCENTAGE OF SUBJECTS REPORTING SEVERE SYMPTOMS

<i>Group</i>	<i>Before treatment</i>	<i>Week 1 of treatment</i>	<i>Week 2 of treatment</i>	<i>Week 3 of treatment</i>	<i>After treatment</i>
Group A (pills containing sugar only)	92	85	83	80	90
Group B (pills containing sugar and drug only)	91	40	29	18	92
Group C (no treatment)	98	95	96	94	96

- (i) State TWO conclusions that can be drawn from these results. Explain your answers.
- (ii) People in both Groups *A* and *B* were all told they were receiving the new drug. In fact, this was not true for Group *A*. Give ONE reason for conducting the experiment in this way.
- (iii) The doctors who administered the drug and analysed the results also did not know which people were in Group *A* or Group *B*. Give ONE reason for this experimental design.
- (iv) Suggest ONE improvement you could make to the experimental design.

QUESTION 5 Scientific Research**Marks**

You have studied at least TWO specific examples in the following list of Australian research programs.

- 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.

- (a) (i) Write down the name of ONE project, with a brief summary of the aim(s) of the project. **5**
- (ii) Discuss the appropriateness of use of a 'control' in the project.
- (iii) Discuss the results of the research and its practical implications.
- (iv) Explain whether the results of the project led to conclusions that were unexpected at the beginning of the project.
- (b) From the above list, select ANOTHER research project. **4**
- (i) Name the project and describe the problem(s) being investigated.
- (ii) Describe ONE method of scientific research that was applied to the project.
- (iii) Give ONE reason for the design of the research project.
- (iv) What further study or work is being done to improve understanding of the problem?

QUESTION 5 (Continued)

Marks

- (c) Write a brief account of a scientific research project that you performed. In your account you must answer the following questions: **6**
- (i) What was the problem?
 - (ii) What literature did you review before designing the research project?
 - (iii) What variable(s) and control(s) were used?
 - (iv) What was your conclusion?
 - (v) What further experiments or improvements to the experiment do you suggest?
- (d) It has been suggested that a driver's reaction time may affect his or her chance of being involved in a car accident. **5**
- (i) State ONE hypothesis that could be tested regarding driver reaction times and car accidents.
 - (ii) Describe an experiment or study that could be undertaken to test your hypothesis. In your description, include:
 - 1 the variables that could be measured or collected;
 - 2 the controls used;
 - 3 the methods of carrying out the experiment or study.

QUESTION 6 Significant Technological Achievements**Marks**

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

<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) From the table, select ONE technological achievement you have studied.

6

- (i) Name the technological achievement.
- (ii) Describe a practical investigation you have undertaken in relation to this technological achievement.
- (iii) How did this practical experience help you to understand the underlying principles of the operation of the technological achievement?
- (iv) Describe another investigation that may have allowed a further understanding of the technological achievement, if you had more resources and time.

QUESTION 6 (Continued)

Marks

- (b) From the table on the previous page, choose ANOTHER technological achievement from a DIFFERENT area to part (a). **6**
- (i) Name the technological achievement.
 - (ii) Describe a practical investigation you have undertaken in relation to this technology.
 - (iii) How did this practical experience help you to understand the underlying principles of operation of the technological achievement?
 - (iv) Describe another investigation that may have allowed a further understanding of the technological achievement, if you had more resources and time.
- (c) In this part of the question you will need to compare the two technological achievements you have selected for your answers to parts (a) and (b). **8**
- (i) Which do you think is the most important of the two technological achievements for people today? Explain your answer.
 - (ii) Compare the effects of these two technologies on the production and distribution of goods or services.
 - (iii) Compare the scientific understandings that existed at the time of the development of each of the technologies.
 - (iv) Which technology has resulted in the greater advance in scientific understanding? Explain your answer.

QUESTION 7 Statistical Methods**Marks**

- (a) (i) An advertisement states that three-quarters of doctors interviewed recommend Brand X in preference to Brand Y. Explain why this may be an example of the misuse of statistics. **4**

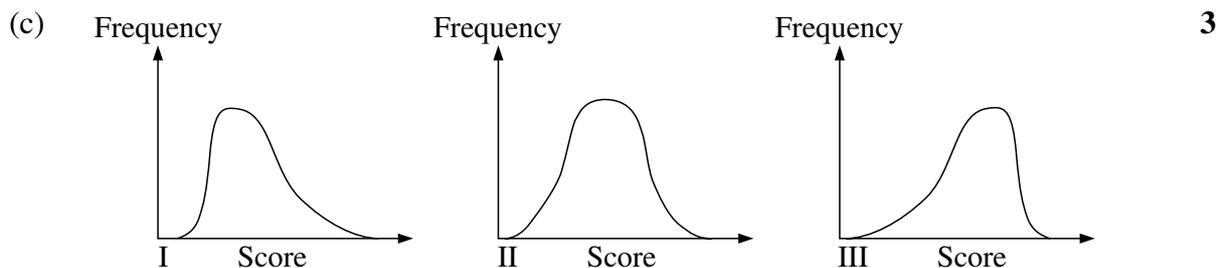
(ii) Describe another way in which statistics may be misused. Give an example.

- (b) A sample of 200 New South Wales residents is to be chosen for a survey. **3**

(i) Describe how the sample would be chosen using:

- 1 simple random sampling;
- 2 systematic sampling.

(ii) What effect would increasing the sample size have on estimating the population mean?



(i) Copy these diagrams into your Writing Booklet.

(ii) On each curve, clearly mark the positions of the mean and median.

- (d) (i) Write down a set of seven numbers where the mode is less than the median AND the median is less than the mean, ie. mode < median < mean. **3**

(ii) What would happen to the mean and standard deviation of your set of numbers if each value was multiplied by 3?

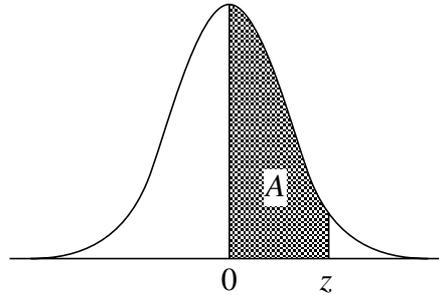
QUESTION 7 (Continued)

Marks

- (e) A vending machine dispenses soft drink automatically into a cup that holds at most 170 mL. The volume dispensed each time is distributed normally with a mean of 150 mL and standard deviation of 8 mL.

7

GRAPH AND TABLE OF THE NORMAL DISTRIBUTION



z	A
0	0
0.5	0.19
1	0.34
1.5	0.43
2	0.475
2.5	0.495
3	0.5

- (i) What is a z score and what is its purpose?
- (ii) Find the probability that a cup taken from the vending machine will contain:
- 1 less than 166 mL;
 - 2 between 146 mL and 162 mL.
- (iii) From 200 operations of the machine, how many individual cups are likely to overflow?

QUESTION 8 Technology and the Consumer**Marks**

- (a) A number of products are available that claim to control fleas on cats. The range of products includes liquid, tablet, collar, injection and powder. **5**

The table below provides information including cost, mode of application, frequency of application, and packaging for the different alternatives.

	<i>Liquid</i>	<i>Tablet</i>	<i>Collar</i>	<i>Injection</i>	<i>Powder</i>
<i>Cost</i>	\$29.00 (for 4 applications)	\$10.90 (packet of 40 tablets)	\$4.80	\$68.00 (including consultation fee)	\$3.80 (for 10 applications)
<i>Mode of application</i>	Apply liquid on fur behind cat's neck	2 tablets taken with food	Placed around cat's neck	Injected into cat	Sprinkle on cat's coat and rub in
<i>Frequency of application</i>	Repeat monthly	Twice a week	Change every 5 months	Repeat every 6 months	Repeat weekly
<i>Packaging</i>	Cardboard backing moulded plastic cover	Plastic container	Cardboard backing moulded plastic cover	Plastic vial with syringe	Plastic shaker container

Assume that you own a cat.

- (i) List TWO factors that would influence your decision when selecting ONE of the above products.
 - (ii) Give ONE reason why there are so many different products that all claim to eliminate or control fleas.
 - (iii) Studies show that injection is the least preferred option for the control of fleas. Give TWO reasons for this finding.
- (b) You are considering manufacturing a new product to control fleas on cats. The product *Flealess* is a full body coat that is worn by the cat. **3**
- (i) Describe ONE test that you would conduct to assess your product against the products shown in the table above.
 - (ii) If the test results showed a market advantage for your product, how would you use this to advertise your product?

QUESTION 8 (Continued)

Marks

You have studied TWO consumer products from the following list:

- bicycle helmets
- cameras
- cosmetics
- devices for heating water
- fertilisers
- hand-held, power-driven tools
- household cleaners
- irons
- portable music players
- sewing machines
- types of household insulation.

- (c) (i) Name ONE product from the above list. **5**
- (ii) Describe the principles of operation for this product.
- (iii) Name ONE material used in producing this product.
- (iv) Give TWO reasons why the material named in part (iii) was an appropriate choice.
- (d) From the above list, select ANOTHER product. **5**
- (i) Name this product.
- (ii) Describe how you evaluated this product in terms of the following criteria:
- 1 safety features;
 - 2 ease of use.
- (iii) Name ONE detrimental effect this product may have on the environment.
- (iv) What procedures are in place to alleviate this problem?
- (e) Compare and contrast the marketing strategies used to promote the product you named in part (c) and the product you named in part (d). **2**

QUESTION 9 Technology of Communication Systems**Marks**

- (a) Pheromones are substances released by one animal and detected by another, causing some sort of physiological reaction. Pheromones are identified through smell. **5**

Trout are acutely sensitive to some pheromones even in extremely low concentrations.

- (i) When would pheromones play an important role in communication between trout?
- (ii) A predator of trout is known to produce the same pheromone as is secreted by the female trout. Explain why this may occur.
- (iii) Humans are able to communicate using a wider range of senses.
 - 1 Give ONE reason why communicating with pheromones is not as reliable for humans as for trout.
 - 2 Give ONE reason why humans make more use of other senses to communicate.

- (b) Telephone, television, radio and computer networks are examples of communication systems that require electricity. **5**

- (i) Describe a simple communication system (other than pheromones) that does not use electricity. Your answer should include:
 - its main purpose
 - how the system operates
 - one limitation of the system.
- (ii) Imagine a futuristic communication system not dependent upon electricity, in which signals are sent instantaneously across the universe.

Discuss ONE positive and ONE negative social implication of this communication system.

QUESTION 9 (Continued)

Marks

(c) Select ONE of the communication systems below:

10

- telephone
 - television
 - radio
 - computer networks.
- (i) Name the system you have studied and refer to it in answering the remainder of part (c).
- (ii) Explain how data is coded in the system.
- (iii) List and describe any specialised equipment needed for decoding the transmitted data.
- (iv) Name TWO sources of noise in this system.
- (v) What effects would the collapse of this communication system have on society?
- (vi) Identify ONE recent technological advance in the system you have studied.
- (vii) Describe ONE benefit that resulted from the adoption of the technological advance you identified in part (vi).

QUESTION 10 The Environment**Marks**

- (a) Some agriculturally important plant species have been genetically engineered to produce a bacterial toxin effective against many insect pests. Such genetically manipulated organisms (GMOs) pass on this insect resistance to successive generations of plants. **8**

Other agricultural experiments are directed towards creating genetically manipulated cereal crops (eg. wheat) which are capable of using nitrogen from the atmosphere.

- (i) Explain how and why the cultivation of GMOs with bacterial toxin may lessen the various negative impacts of chemical pesticides on the environment.
 - (ii) Explain how and why the cultivation of cereal crops that can use nitrogen from the atmosphere may lessen the various negative impacts of synthetic nitrogen-based fertilisers on the environment.
 - (iii) Soil salination is a problem in Australia. Suggest TWO possible ways other types of genetic manipulation of organisms might be used to reduce soil salination problems.
 - (iv) Despite the apparent environmental benefits of genetically manipulated organisms in agriculture, many environmental activists are alarmed at the environmental release of such genetically manipulated organisms. Give TWO possible reasons for such concern.
- (b) You have undertaken research and prepared an environmental report on an issue of local significance. **7**
- (i) What was the issue of local significance that you identified?
 - (ii) Describe the methods you used to investigate this issue.
 - (iii) Discuss the findings of your research.
 - (iv) Discuss how the local issue relates to ONE of the global issues you have studied.
 - (v) Discuss TWO changes you might suggest in individual or community behaviour that might lessen the environmental impact of the local issue you have studied.

QUESTION 10 (Continued)

Marks

- (c) Australia has the second highest per capita production of greenhouse gases of any country in the world. **5**
- (i) What are greenhouse gases and why are they an important global issue?
 - (ii) Australia did not fully agree with recent proposals to reduce greenhouse gas emission.
 - 1 Suggest TWO possible reasons for the Australian decision.
 - 2 Suggest ONE way that countries like Australia could reduce greenhouse emissions.

End of paper

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