BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

2000

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) Different types of clothing are placed in a washing machine. The water level and   **6**
type of wash (delicate or heavy) are set on dials by the operator. The machine is
started, and at the end of the wash the machine stops.

A home heating system allows the operator to set a room temperature on a dial.
During operation the room remains at this temperature even though the outside
temperature varies.

With reference to the washing machine and the heating system described above,
answer the following questions.

  (i)   Name which of the two systems is an open loop system.

  (ii) Explain how the heating system works to maintain the room
        temperature.

  (iii) Explain the function of ONE actuator in the washing machine.

  (iv) Describe ONE improvement that would make this washing machine
        'smarter'.

  (v)   Describe the function of ONE sensor in the heating system.

(b) The signalling system on the Illawarra Freeway provides signs to warn motorists   **8**
of excessive speed in normal driving conditions and advisable speeds when fog
is present. Two sensors in the road detect each car as it passes, and another
sensor detects the presence of fog.

  (i)   Describe how a sensor designed to detect fog would work.

  (ii) Explain why two road sensors are required to detect each car.

  (iii) What are TWO advantages of this system?

  (iv) Name ONE function that could easily be added to the system to reinforce
        safe driving.

  (v)   What new component would need to be added to achieve part (iv)?

  (vi) What implication would the new component have for society?

QUESTION 1 (Continued) **Marks**

(c)   Choose ONE working model of a computer-controlled system you have   **6**
assembled. Do NOT use the systems from part (a) or part (b).

    (i)   Name the system.

    (ii)   Draw and label diagrams to show how the components connect together
to form a working system.

    (iii)   Give a practical *real world* application for this system.

    (iv)   If the *real world* application in part (iii) failed for a long period of time,
describe TWO effects that this would have on people's daily lives.

    (v)   State ONE ethical issue that needs to be considered when designing the
*real world* application of this computer-controlled system.

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QUESTION 2 Applied Mathematical Skills   **Marks**

(a) 'Basil's Bakehouse' bakes and sells chocolate chip and blueberry muffins.   **6**

One-and-a-half times as many chocolate chip muffins as blueberry muffins are sold.

Each chocolate chip muffin sold yields $0·50 profit, while each blueberry muffin sold yields $0·60 profit.

The graph below indicates the maximum total number of muffins baked each day.
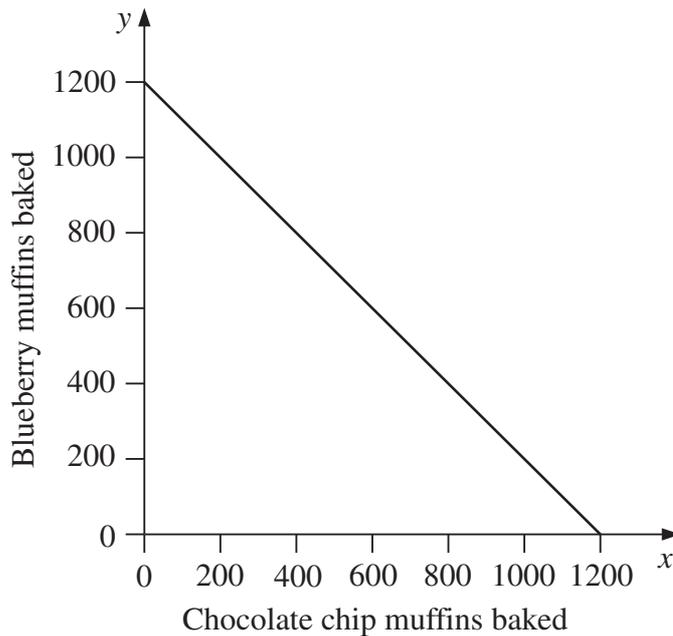
(i) What is the maximum total number of muffins baked each day?

(ii) Let x represent the number of chocolate chip muffins sold, and let y represent the number of blueberry muffins sold. Write down the equation for the profit *(P)* in terms of x and y.

(iii) During one day, Basil sold 600 chocolate chip muffins and 400 blueberry muffins. Calculate the profit made.

(iv) What is the maximum daily profit Basil can make under the given constraints? Show all necessary working.

QUESTION 2 (Continued)   **Marks**

(b) The express lane at 'MoreFood Supermarkets' feeds into one of three checkout   **4**
counters.

At 9.00 am only one of the checkout counters is open and there are eight
customers waiting in the queue. Another customer joins the queue every
30 seconds.

The remaining two checkout counters are opened at 9.05 am.

Each counter serves one customer every minute.

   (i)   At 9.00 am, Mary is the eighth person in the queue. At what time is she
served?

   (ii)   How many people are in the queue at 9.15 am?

(c) The value of a rare antique was seen to follow the compound interest formula   **4**

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

At the beginning of 1994, the item was bought for \$15 000. It was again sold at
the beginning of 2000, for \$24 472.

   (i)   What was the annual rate of increase of the price of the antique?

   (ii)   If the annual rate of increase stays the same, in what year will the
original value of the antique have doubled?

Question 2 continues on page 6

QUESTION 2 (Continued)   **Marks**

(d)   The graph shows the world's estimated population from 1950 to 2050.   **6**

WORLD POPULATION: 1950 – 2050
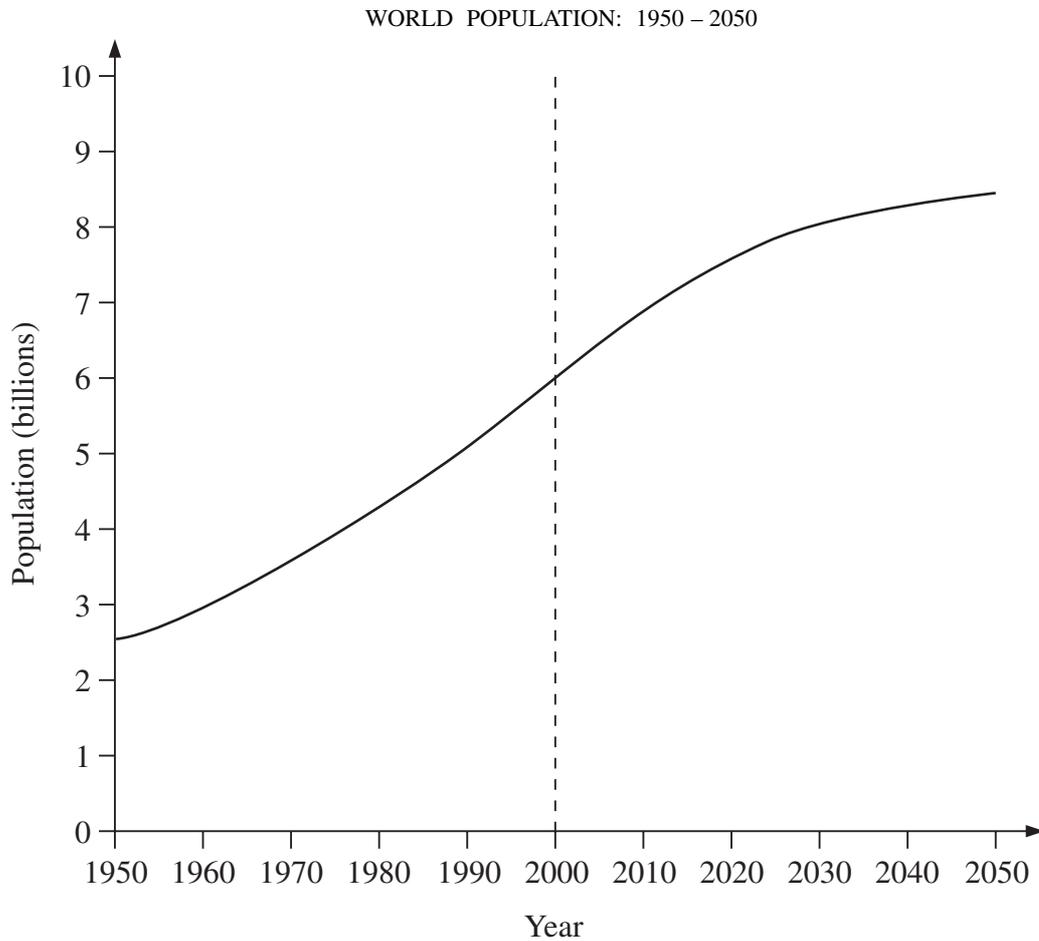
(i)   Name the type of population growth represented by this graph.

(ii)   Describe TWO main features of this type of growth.

(iii) Use the graph to calculate the average rate of population growth between 2000 and 2050.

(iv)   Name TWO factors that could have contributed to the change in population growth between 2000 and 2050.

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QUESTION 3 Mathematical Ideas   **Marks**

(a)   Galileo was the first person to make serious use of the telescope to study the sky.   **4**
      Name TWO discoveries he made and explain how these discoveries affected
      scientific beliefs of the time.

(b)   One approximation of π is given by the series   **5**

$$\pi^2 = 6\left(1 + \frac{1}{2^2} + \frac{1}{3^2} + \ldots\right)$$

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

   (ii) Find an approximation for π given by the first five terms of the series
         (correct to three decimal places). Show all necessary working.

   (iii) Archimedes (287–212 BC) gave a bounded approximation of π as
         follows:

$$\frac{223}{71} < \pi < \frac{22}{7}$$

         Briefly describe the method used by Archimedes to obtain this
         approximation.

(c)   The wheels shown in the diagram are connected by belts.   **5**
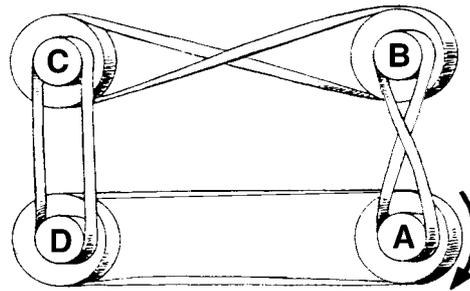
   (i)   If wheel **A** rotates clockwise, as indicated, can the remaining three
         wheels also rotate? If so, which way does each wheel turn?

   (ii) The belt joining wheels **A** and **B** could be a Möbius strip. Describe TWO
         significant features of a Möbius strip.

QUESTION 3 (Continued)   **Marks**

(d)   (i)   What is meant by *geostationary orbit*?   **3**

        (ii) Name ONE application where a *geostationary orbit* can be used.

(e)   The first three steps in the construction of a fractal pattern based on an   **3**
      equilateral triangle are shown below.
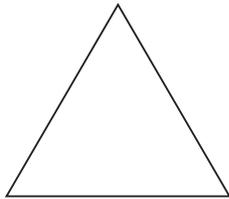
Original shape   Stage 1   Stage 2
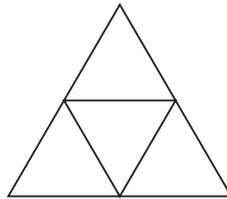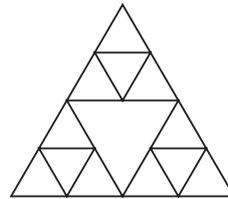
        (i)   Give a brief description of the rule used to generate this fractal.

        (ii) If the next stage of this fractal is generated, how many *new* congruent
              triangles will be formed?

Please turn over

QUESTION 4 Science and Medicine   **Marks**

(a)   You have studied ONE of the following medical conditions: **9**

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

    (i)   Name the condition you have studied.

   (ii)   Describe how this condition disrupts the healthy functioning of the body.

  (iii)   State ONE significant symptom of this condition and explain how this symptom is related to the disruption of healthy functioning, mentioned in part (ii).

  (iv)   Describe how detailed observation and/or careful experimentation identified the major factor(s) contributing to this condition.

   (v)   'The progression of any medical condition is the result of a complex interaction between nature (our genetic make-up) and nurture (our environment and lifestyle).'

          In the light of this statement, discuss the current and historical world incidence of the medical condition you have studied.

  (vi)   For this condition, describe how a rigorous scientific understanding of cause and effect has led to the development of safe and effective pharmaceuticals.

 (vii)   Describe ONE way scientific advances in the treatment of this condition may lead to long-term control.

QUESTION 4 (Continued)   **Marks**

(b)   You have studied in detail ONE of the following diagnostic imaging techniques: **6**

   • radioisotopes

   • ultrasound

   • X-rays and CAT scans.

   (i)   Name the technique you have studied.

   (ii)   Briefly describe the scientific principles underlying the development of this technique.

   (iii) State ONE way in which the technique you have studied may itself constitute a health hazard, and explain how steps have been taken to minimise the risk from this hazard.

   (iv)   State ONE way in which the technique is limited in its imaging potential, and suggest how this limitation may be overcome by the use of other diagnostic procedures.

(c)   Many people believe that natural herbal remedies for any given medical condition are better and safer than prescription drugs for the condition.   **5**

   (i)   Briefly describe how you would design a controlled scientific trial to compare the effectiveness of a herbal remedy and a prescription drug for the treatment of a given medical condition.

   (ii)   Comment on the ethical implications of such a trial.

   (iii) Explain how current evaluative procedures used in the development of a prescription drug are designed to ensure the drug's safety.

QUESTION 5 Scientific Research   **Marks**

You have studied TWO of the following significant pieces of scientific research carried out in Australia:

- 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)   Name ONE project from the list above.   **6**

        (ii)   Describe the *methodology* used to carry out the project.

        (iii) Describe the nature of the data collected from the research.

        (iv)   State ONE significant conclusion from the project.

        (v)   Outline ONE advantage to society gained as a result of this project.

(b)   You have carried out a research project of your own and presented a report.   **7**

        (i)   Name the research project that you presented.

        (ii)   Outline the research that you carried out to help you understand the
               problem.

        (iii) Explain how you set up a *control* or *standard* for your project.

        (iv)   Explain what is meant by *reliability* in scientific research.

        (v)   State ONE significant conclusion you made from your project.

Marks
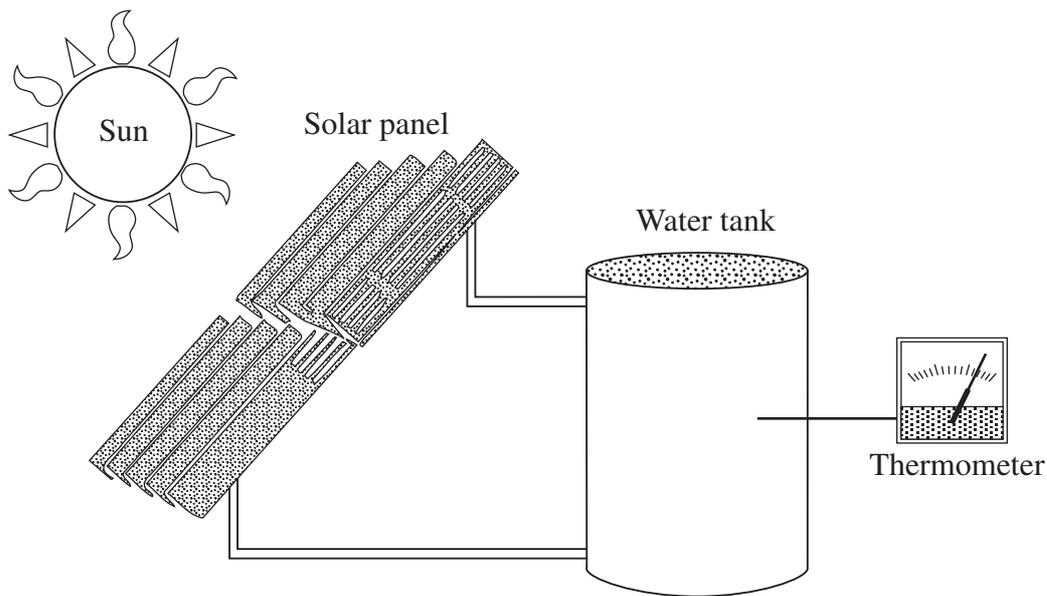
(c)   The diagram shows a solar hot water system. The Sun's rays strike the solar   **7**
      panel and the water temperature is measured by the thermometer.

   (i)   State ONE hypothesis relating to the performance of the solar hot water
         system that you could test with a research experiment.

   (ii)   Describe the method you would use to test your hypothesis.

   (iii)   Name ONE variable in the experiment.

   (iv)   Describe the results you would expect from your experiment if the
          hypothesis you stated in part (i) was true?

   (v)   Describe ONE improvement you could make to your experiment.

QUESTION 6 Significant Technological Achievements   **Marks**

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

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 table, select ONE technological achievement you have studied.   **7**

    (i) Name the technological achievement.

    (ii) Describe the nature of the technology that existed prior to the technological achievement named in part (i).

    (iii) Explain the principles underlying the technological achievement.

    (iv) Describe TWO ways in which society benefited from the introduction of the technological achievement.

    (v) Describe ONE negative effect of this achievement on individuals or society.

QUESTION 6 (Continued)   **Marks**

(b)   From the table on the previous page, choose ANOTHER technological   **6**
      achievement from a DIFFERENT AREA to the one you chose in part (a).

      (i)   Name the technological achievement.

      (ii)   Describe the significant needs for this technological achievement.

      (iii) Explain the main scientific principle(s) underlying the technological
             achievement.

      (iv)   Describe TWO ways by which this technological achievement has
             influenced production.

(c)   Select ONE of the technological achievements you have described in part (a)   **4**
      OR part (b).

      (i)   Name the technological achievement.

      (ii)   Describe a practical activity that you were involved in, that helped you
             understand the achievement.

      (iii) Explain the conclusions you came to about the technological
             achievement following your practical activity.

(d)   'Technological achievements always occur in response to a need, and only result   **3**
      in benefits to society.'

      Discuss this statement.

QUESTION 7 Statistical Methods   **Marks**

(a)   On a suburban railway station, the waiting time for passengers on a certain   **4**
      platform was seen to follow a normal distribution, with a mean of 12 minutes
      and a standard deviation of 2 minutes.

GRAPH AND TABLE OF THE NORMAL DISTRIBUTION
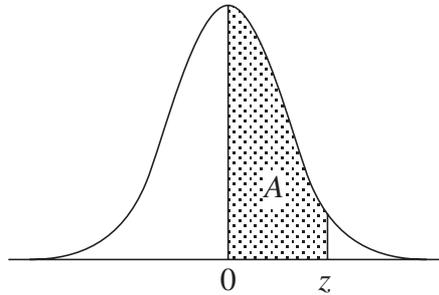
z	A
0	0
0·5	0·19
1	0·34
1·5	0·43
2	0·475
2·5	0·495
3	0·5

From the graph and table above:

   (i)   Find the probability that a person standing on the platform will wait:

      1   longer than 16 minutes;

      2   between 8 and 13 minutes.

   (ii) During a particular week, the passenger waiting time for 42 of the total
         number of trains was greater than 15 minutes. Calculate the total number
         of trains that arrived at this platform during this week.

(b)   You have undertaken a research project that used a survey to test a hypothesis.   **4**

      Outline the design of the research project. Include in your answer the
      hypothesis, the survey technique used, the sample size and the results.

QUESTION 7 (Continued) **Marks**

(c) The table shows the placings of a particular greyhound in its last 80 races. **4**

Placing	Frequency
1	3
2	8
3	22
4	19
5	15
6	9
7	2
8	2

(i) Over the next ten races, the greyhound finished in fourth place every time. Which of the following statistical measures would change? (Show all working.)

1 Mean

2 Mode

3 Median

(ii) This distribution is said to be *positively skewed*.

What is meant by this term?

Question 7 continues on page 18

QUESTION 7 (Continued)   **Marks**

(d)   The temperature in a town was recorded every hour from 1 pm until 6 pm.   **3**

AFTERNOON TEMPERATURE
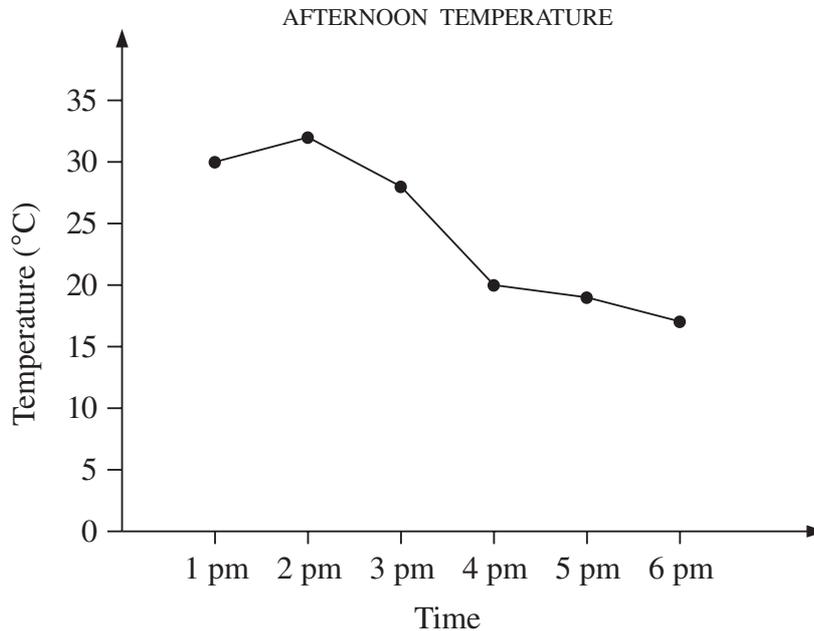
(i)   Calculate the mean temperature for the period given.

(ii)   In which hour was the rate of change of temperature greatest?

(e)   The table below provides information about life expectancy in Australia   **5**
       from 1946 to 1996.

	1946	*1956*	*1966*	*1976*	*1986*	*1996*
Male	65	67	67	69	72	75
Female	69	73	74	76	79	81

(i)   On the same set of axes, construct TWO line graphs by plotting the
       information.

(ii)   Discuss the changes that have occurred in life expectancy in males and
       females in the periods 1946 to 1956 and 1986 to 1996.

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QUESTION 8 Technology and the Consumer   **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.

(a)   (i)   Name ONE product from the list.   **6**

       (ii)   What need in society prompted the development of this product?

      (iii)   Identify the most recent development of this product in terms of:

              1   safety features;

              2   marketing strategies.

       (iv)   Describe ONE effect this product has had on the environment.

        (v)   How could you confirm that the environmental effect mentioned in part (iv) does exist?

(b)   From the list above, select ANOTHER product.   **5**

        (i)   Name this product.

       (ii)   How does this product operate?

      (iii)   Explain how certain individuals may be restricted in their use of this product.

       (iv)   Describe how aesthetic changes in the product could affect the originally intended function.

QUESTION 8 (Continued)   **Marks**

(c)   Consider the product you named in part (a) and the product you named in   **2**
      part (b).

      For ONE of these products, explain whether *aesthetics* OR *function*
      predominates in its marketing.

(d)   Over the past few years, the introduction of soy and rice milk products has seen   **7**
      an increase in advertisements for cow's milk products to maintain their strong
      market share.

      The table below contains information about a wide range of milk types, all based
      on a one-litre container.

Product name	Source of product	Fat content	Calories	Protein	Calcium	Fresh or long-life	Cost
So Rice	Rice	2·5 g	162	1·5 g	Not given	Long-life	$1·83
Soy Good	Soy	7·25 g	159	5·0 g	Not given	Long-life	$1·93
Soy Good Lite	Soy	1·3 g	120	8·8 g	Not given	Long-life	$1·97
So Rice Lite	Rice	3·75 g	138	7·5 g	300 mg	Long-life	$1·93
Figure	Cow	0·4 g	120	12·0 g	408 mg	Fresh	$1·50
Farmer's Favourite	Cow	3·3 g	138	10·8 g	363 mg	Fresh	$1·62
All milk	Cow	9·8 g	170	8·5 g	288 mg	Fresh	$1·27

      Use the table to answer parts (i) and (ii).

      (i)   State TWO factors that would influence your decision to buy any of
            these milks.

      (ii) State ONE reason for the large range of milk products.

      A milk marketing board has considered the possibility of marketing a cow's
      milk product that can be stored in a cupboard after it has been refrigerated.

      (iii) Describe ONE method you could use to assess the potential market for
             this product.

      (iv)   Describe how you would promote this product to gain a market share.

      (v)   State ONE factor that government should consider before allowing the
             product to be marketed.

QUESTION 9 Technology of Communication Systems   **Marks**

(a)   Braille is a communication system designed to assist vision-impaired people to   **4**
read.

Patterns of raised dots represent letters and numbers. Vision-impaired people
run their fingers over the raised dots to interpret the message.

  (i)   Describe ONE feature of normal reading that is NOT provided for by the
Braille system.

  (ii)   State ONE advantage to society provided by this system.

  (iii)   Describe what you consider to be TWO sources of *noise* in the Braille
system.

(b)   Select ONE of the following communication systems: **9**

  • telephone

  • radio

  • computer networks

  • television.

  (i)   Name the system.

  (ii)   Explain how TWO of the main items of equipment used in the system
work.

  (iii)   Explain how the system has improved people's lifestyle.

  (iv)   Explain how the coded signal passes through the communication
medium used by the system.

  (v)   Name ONE source of *noise*, and explain how it actually affects the
system's operation.

  (vi)   How can the noise you mentioned in part (v) be reduced?

QUESTION 9 (Continued)   **Marks**

(c)   Choose ONE communication system other than those mentioned in   **5**
       parts (a) and (b).

   (i)   Name the system.

  (ii)   Describe how the message is:

     1   encoded;

     2   transmitted;

     3   decoded.

 (iii)   Describe TWO limitations of this system.

(d)   Describe the fundamental principles of communication.   **2**

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QUESTION 10 The Environment   **Marks**

(a) You have investigated a local environmental issue of importance to your   **9**
community.

    (i)   Name the issue of local significance that you investigated.

    (ii)   How did you became aware of this local problem?

    (iii) Discuss any special techniques you may have used to make appropriate and careful observations and measurements during your investigation.

    (iv) How might the results of your investigation lead to more effective management of your local problem?

    (v)   Explain how the local issue you investigated is linked to wider environmental issues.

    (vi) Identify ONE way by which more effective ecological management of your local environmental problem could benefit your local economy.

    (vii) Identify ONE way you might effectively raise public awareness of your local problem and bring pressure to bear for change.

(b) Australia now leads the world in per capita greenhouse gas production.   **7**

    (i)   What are greenhouse gases, and why are they an important global issue?

    (ii)   Compare and contrast the production of greenhouse gases in the city and in the country.

    (iii) Identify ONE way of reducing greenhouse gas emission by changing *technology*.

    (iv) Identify ONE way of reducing greenhouse gas emission by changing *lifestyle*.

(c) Last year a massive hole in the ozone layer developed directly over eastern   **4**
Australia.

    (i)   Explain the significance of this hole in the ozone layer to human health and to the environment generally.

    (ii)   How did this hole in the ozone layer develop?

    (iii) What is being done to arrest or repair this damage?

End of paper