BOARD OF STUDIES
NEW SOUTH WALES

2005

HIGHER SCHOOL CERTIFICATE EXAMINATION

Senior Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your Centre Number and Student Number at the top of pages 9, 13 and 17

Total marks – 100

Section I Pages 2–19

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16–27
- Allow about 1 hour and 45 minutes for this part

Section II Pages 21–33

25 marks

- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

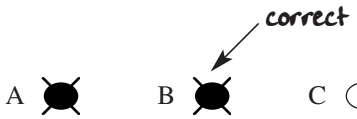
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

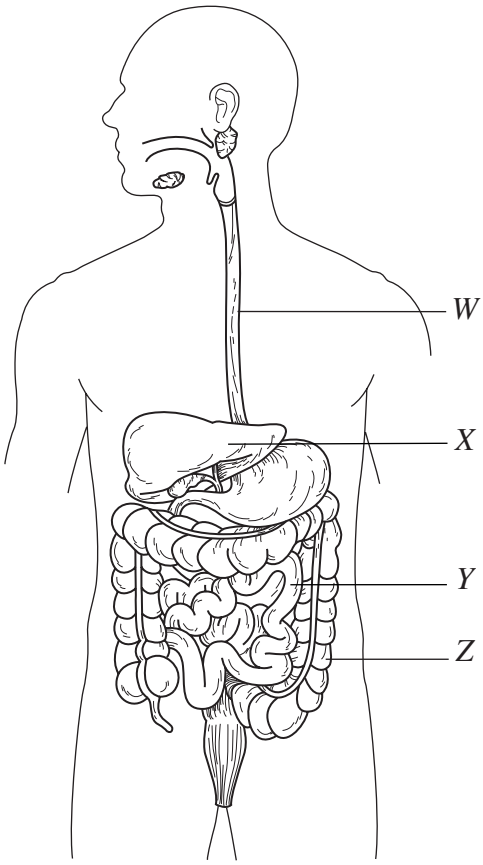
A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



A ⊗ B ⊗ C ○ D ○

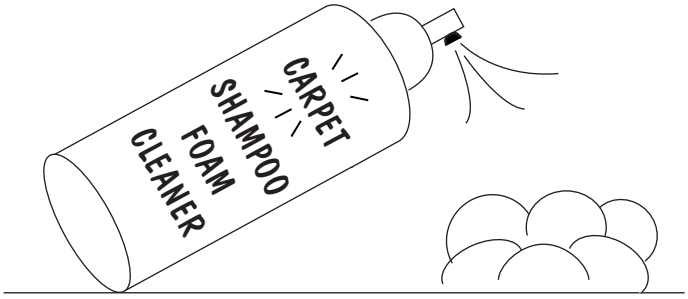
1 The diagram shows the human digestive system, with four structures labelled *W*, *X*, *Y* and *Z*.



Which row in the table correctly names each labelled structure?

	W	*X*	*Y*	*Z*
(A)	Trachea	Stomach	Small intestine	Large intestine
(B)	Trachea	Liver	Pancreas	Small intestine
(C)	Oesophagus	Stomach	Pancreas	Small intestine
(D)	Oesophagus	Liver	Small intestine	Large intestine

2 This carpet shampoo is a foam cleaner.



What combination of substances makes up this colloid?

(A) Gas in a gas

(B) Gas in a liquid

(C) Liquid in a liquid

(D) Solid in a liquid

3 A vegetable containing four vitamins, *P*, *Q*, *R* and *S*, was boiled in pure water. The amounts of these vitamins were recorded as stars (∗) in the following table.

Amount of vitamins before and after cooking

Vitamin	*Vegetable before cooking*	*Vegetable after cooking*	*Water remaining after cooking*
P	∗ ∗ ∗ ∗ ∗ ∗	∗ ∗ ∗ ∗ ∗	∗
Q	∗ ∗ ∗ ∗ ∗ ∗	∗ ∗ ∗ ∗	∗ ∗
R	∗ ∗ ∗ ∗	∗	∗ ∗ ∗
S	∗ ∗ ∗ ∗ ∗ ∗	∗ ∗ ∗	∗ ∗ ∗

Key

Lowest amount of vitamin found in sample ∗

Highest amount of vitamin found in sample ∗ ∗ ∗ ∗ ∗ ∗

Which vitamin is most water soluble?

(A) *P*

(B) *Q*

(C) *R*

(D) *S*

4 Sub-dermal implants were developed as a way of administering some drugs.

Which of the following is the medical advantage in using a sub-dermal implant to deliver a drug?

(A) The drug will dissolve in an alcohol solvent.

(B) The drug is delivered gradually to the circulatory system.

(C) The drug is distributed rapidly to the central nervous system.

(D) The drug is contained in a transparent disc that matches skin colour.

5 Shampoos, skin cleansers and soaps all remove oil from skin and hair.

How do these products affect the oil so that it can be removed by water?

(A) They emulsify the oil.

(B) They make the oil a surfactant.

(C) They decrease the pH of the oil.

(D) They increase the surface tension of the oil.

6 Both soft and hard body parts can be replaced by biomedical devices.

Which of the following biomedical devices are all used to replace the function of damaged or diseased soft body parts?

(A) Crowns, pins, plates

(B) Artificial valves, lenses, pacemakers

(C) Artificial joints, hearing aids, screws

(D) Cochlear implants, dentures, prosthetic limbs

7 Many different materials have been used in the manufacture of biomedical devices.

Which of the following materials is best suited for heart valves?

(A) Ceramics

(B) Superalloy

(C) Teflon

(D) Ultrahigh molecular weight polyethylene (UHMWPE)

8 Which of the following are both life-support systems?

(A) Heart-lung bypass, kidney dialysis

(B) Heart-lung bypass, thermography

(C) Kidney dialysis, ultrasound

(D) Thermography, ultrasound

9 Which of the following events is most likely to cause the sound of the heartbeat?

(A) Heart valves closing

(B) Heart valves opening

(C) Heart muscles contracting

(D) Flow of blood through the heart

10 When you breathe, you can feel your chest moving.

How does the diaphragm cause air to enter the lungs?

(A) The diaphragm relaxes and moves upward.

(B) The diaphragm relaxes and moves downward.

(C) The diaphragm contracts and moves upward.

(D) The diaphragm contracts and moves downward.

11 What form of energy is used to transmit telephone conversations along optic fibres?

(A) Electrical

(B) Light

(C) Microwave

(D) Sound

12 Survival kits carried in aircraft often contain a signalling mirror, which can be used to aim reflected sunlight to attract the attention of potential rescuers.

Which of the following correctly classifies this simple kind of information system?

(A) Electronic, long-distance, nonverbal

(B) Electronic, short-distance, verbal

(C) Non-electronic, long-distance, verbal

(D) Non-electronic, short-distance, nonverbal

13 Which of the following is a major advantage of radio waves over microwaves in communication?

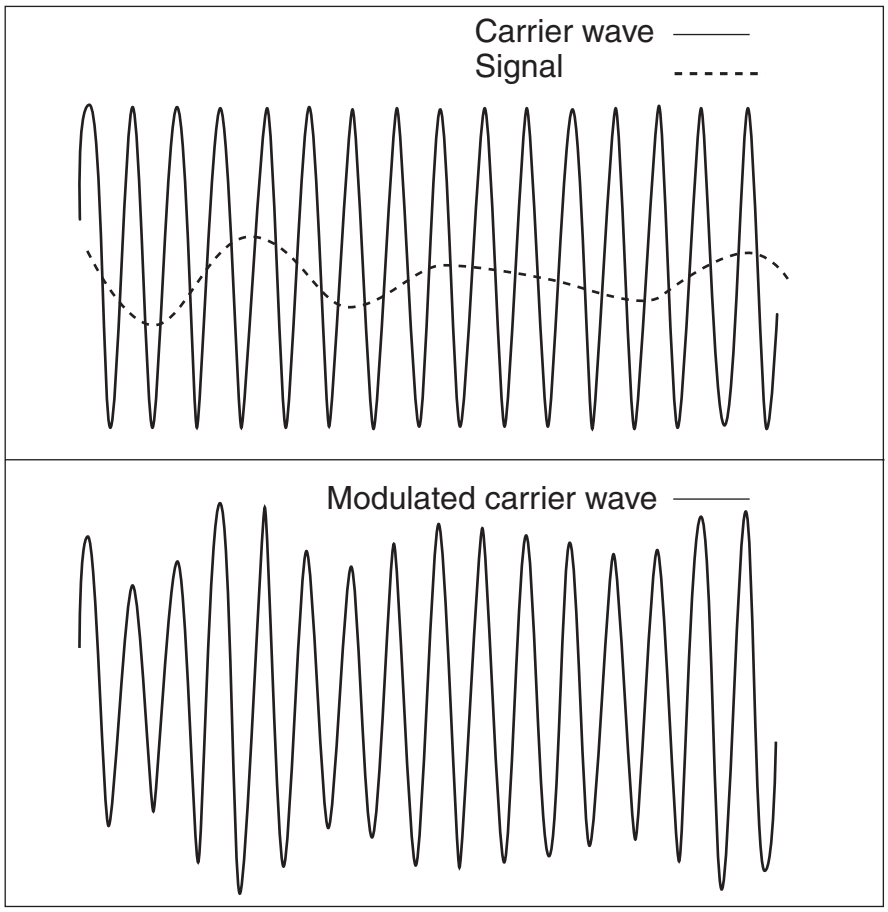
(A) Ability to travel in a straight line

(B) Ability to travel through a vacuum

(C) Fewer transmission towers required

(D) Greater speed of signal transmission

14 The diagram shows a technique used by a communication system in which a signal has been superimposed on an electromagnetic carrier wave to produce a modulated carrier wave.



Which communication system uses this technique?

(A) AM radio

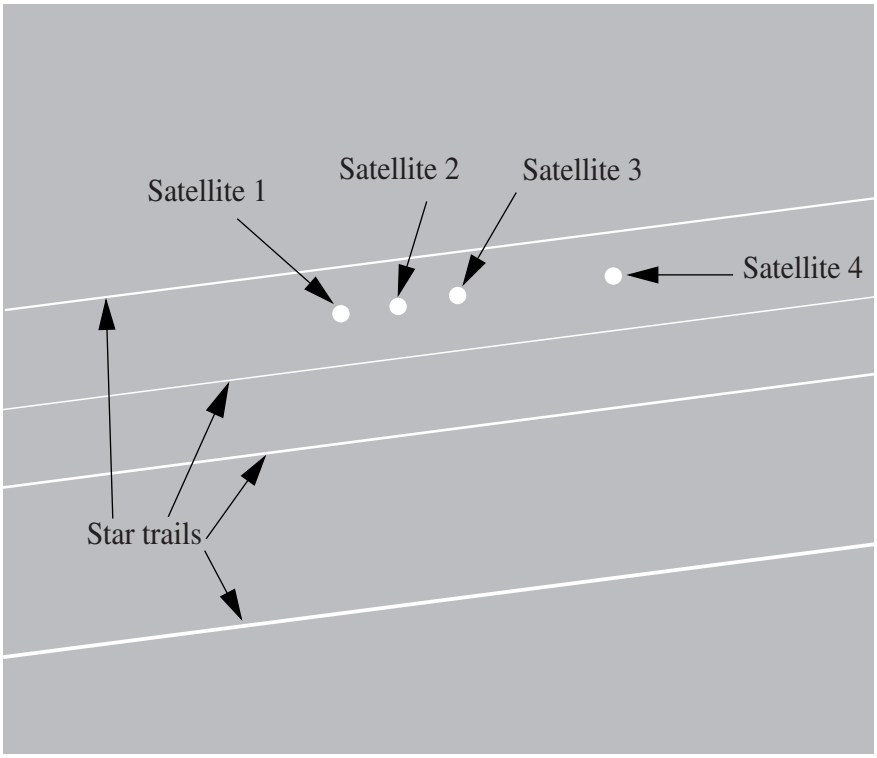
(B) FM radio

(C) Compact disc players

(D) Digital mobile telephones

15 As Earth rotates during a five-hour period, a long-exposure photograph shows:

- four commercial communication satellites hovering above Earth; and
- star trails created by the apparent movement of some stars of the Southern Cross in the night sky.



Why do satellites appear in the photograph as distinct objects, while the stars are recorded as star trails?

(A) The satellites are in a fixed position relative to the stars, and Earth is rotating.

(B) Earth is in a fixed position relative to the stars, and the satellites revolve rapidly around Earth.

(C) The satellites all have the same revolutionary period as the rotation of Earth, whereas the stars are in a fixed position.

(D) The satellites and the stars are all stationary relative to each other, and Earth is rotating with a period of rotation of 23 hours 56 minutes and 4 seconds.

Centre Number

Student Number

Section I (continued)

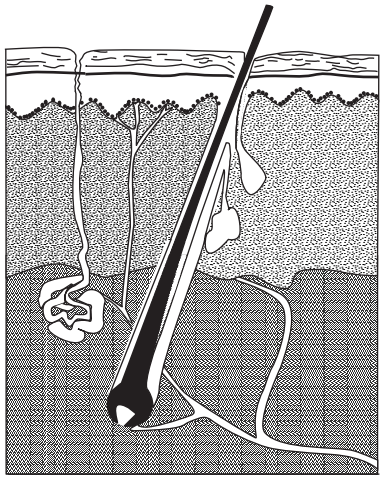
Part B – 60 marks
Attempt Questions 16–27
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Marks

Question 16 (5 marks)

The diagram shows a cross-section of human skin.



(a) Human skin has a number of important roles. One of these is to contain all of the body's tissues and organs. **2**

Identify TWO other roles of human skin.

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Question 16 continues on page 10

Marks

Question 16 (continued)

(b) A skin-care specialist wanted to make a new product which contained three special solid ingredients. Their properties are listed below.

Solid ingredient	*Soluble in water*	*Soluble in alcohol*
Ingredient 1	No	No
Ingredient 2	Yes	No
Ingredient 3	No	Yes

He found that if he mixed water and alcohol with the three solids, he produced a smooth, flowing liquid. The solids did not settle out.

(i) Identify the solvents used in this skin-care liquid. **1**

(1) .....

(2) .....

(ii) Explain what type of mixture Ingredient 1 has formed in this skin-care product. **2**

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Question 17 (3 marks)

Australian Standard 4351 requires that detergent products completely biodegrade within 28 days.

Explain why it is important for detergents to be biodegradable. **3**

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Marks

Question 18 (6 marks)

(a) Two students investigated how quickly two different tablets dissolved in three solvents. Their results are shown below.

Average time taken to dissolve

Tablet	*Time taken in water* (min)	*Time taken in weak alkali* (min)	*Time taken in weak acid* (min)
A	5	5	5
B	>120	45	>120

(i) Identify ONE variable that they should have kept constant in this investigation. **1**

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(ii) The students correctly identified *Tablet B* as an enteric-coated tablet. Explain why they came to this conclusion. **2**

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(b) Compare the difference in pH of the stomach and the small intestine, and relate it to the roles of these organs. **3**

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Marks

Question 19 (6 marks)

Water is essential because it has a number of roles. **6**

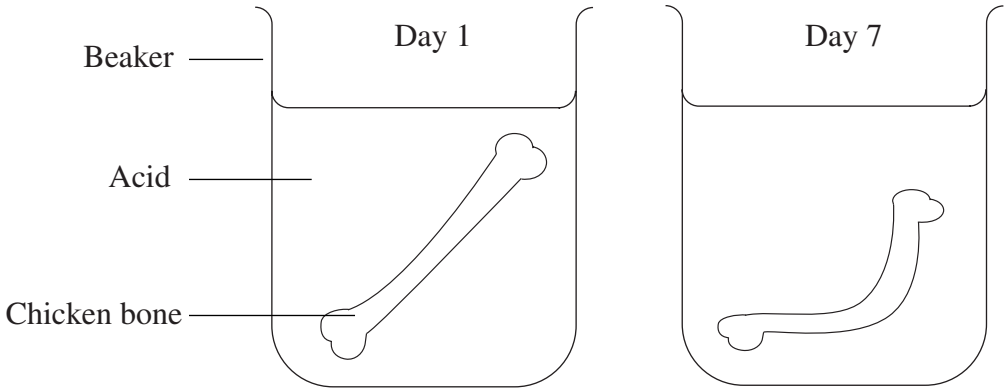
- It is important for the human body in circulation, digestion and respiration.
- It is the necessary component of a huge variety of products used on humans externally, for example, drugs, shampoos, detergents and cosmetics.

Analyse the role of water as a solvent in both the internal and external environments of humans.

Marks

Question 20 (4 marks)

A first-hand investigation was carried out using chicken bones as shown in the diagrams.



(a) State an aim for this investigation. **1**

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(b) Explain ONE safe work practice for this investigation. **1**

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(c) Interpret the results of this investigation in terms of ONE property of bones. **2**

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Marks

Question 21 (8 marks)

(a) Outline THREE impacts on society of EITHER heart transplants OR artificial hearts. **3**

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(b) Improvements in pacemakers have been made possible through advances in technologies. **5**

Justify this statement.

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Marks

Question 22 (4 marks)

The diagram shows the human respiratory system.

(a) Name the part labelled *X*. **1**

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(b) What is the function of the trachea? **1**

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(c) Relate the function of the alveoli to their structure. **2**

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Marks

Question 23 (4 marks)

(a) Identify ONE minimally invasive medical technique. **1**

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(b) Discuss the importance of magnetic resonance imaging (MRI) as a non-invasive diagnostic medical technique. **3**

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Marks

Question 24 (8 marks)

(a) Draw a flowchart to describe the energy transfers involved in the decoding of information from a compact disc. **3**

(b) Analyse the impact of coding information into a series of zeros and ones on the development of communication technologies. **5**

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Marks

Question 25 (4 marks)

Lee was asked to process and analyse information from secondary sources to compare the properties of copper cables with fibre optics when used in communication systems. She gathered the following information from an internet site.

> **Copper cable**
>
> The electrical transmission through a copper cable has a bandwidth of approximately 10^8 Hz and the transition time for each pulse is 10^{-8} second. Due to electromagnetic interference (EMI) and energy loss, the signal loss is greater than 20 dB/km. The cable is large, heavy and expensive, and the signal remains electrical.
>
> **Fibre optics**
>
> The transmission of a signal through an optic fibre has a bandwidth of 10^{14} Hz and transition time for each pulse is 10^{-11} second. The glass used to make the optical fibre is cheaper, smaller, lighter and more fragile than copper cable. There is no EMI and little energy loss. The signal loss is approximately 0.2 dB/km, but the signal must be converted from electrical to optical and then back to electrical.

(a) Use the information gathered by Lee to complete the table comparing copper cables with fibre optics in relation to their band width, signal loss and transition time for pulses. **2**

Cable	*Band width*	*Signal loss*	*Transition time per pulse*
Copper cable			
Fibre optic cable			

(b) Using Lee's gathered data, explain why the fibre optic cable has a faster rate of information transfer than the copper cable. **2**

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Marks

Question 26 (4 marks)

Explain ONE advantage and ONE disadvantage of using radio waves in communication. **4**

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Question 27 (4 marks)

Predict a possible future direction of research into telecommunications, and justify your prediction. **4**

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Senior Science

Section II

25 marks
Attempt ONE question from Questions 28–32
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Marks

Question 28 — Polymers (25 marks)

(a) (i) During your study of this option you have undertaken a range of practical experiences that have involved collecting data. **2**

Identify TWO differences between first-hand and secondary-source investigations.

A group of students used the following procedure to compare the effect of heat on a thermosetting plastic and a thermoplastic.

Procedure

1. Cover a piece of thermosetting plastic with water, and boil for 10 minutes.
2. Remove the plastic from the water, and clamp it so that it is held horizontally.
3. Immediately place a piece of metal on the unclamped end of the plastic.
4. Measure the vertical distance through which the unclamped end of the plastic moves when the piece of metal is placed on it.
5. Record your results.
6. Repeat steps 1 to 5 three times, using water at 80°C, 60°C and 40°C in place of the boiling water.
7. Repeat steps 1 to 6 for a thermoplastic.

(ii) From your knowledge of thermosetting plastics and thermoplastics, predict the results of this investigation. **2**

(b) (i) Distinguish between recycling and downcycling of plastics. **2**

(ii) Assess the viability of recycling plastics that contain stabilisers and fire-retardants. **4**

Question 28 continues on page 23

Question 28 (continued)

(c) Assess the impact on society of synthetic polymers that have been designed to have specific properties suitable for their intended use. **7**

(d) Two students investigated the strength of cotton fibres. The results from their investigation are recorded in the table.

Colour of cotton	*Thickness of cotton* (mm)	*Average mass (in grams) needed to break different samples of cotton*		
		20 cm lengths of cotton	30 cm lengths of cotton	40 cm lengths of cotton
White	0.05	410	420	420
	0.07	590	580	580
	0.10	750	740	750
Orange	0.05	420	420	430
	0.07	600	610	590
	0.10	740	750	740
Black	0.05	420	410	420
	0.07	580	590	590
	0.10	750	740	730

(i) Draw a labelled diagram of the equipment you could use to carry out this investigation. **2**

(ii) The students reported their results in terms of the average mass needed to break the cotton. **2**

Explain why they averaged their results.

(iii) Justify THREE different conclusions that could be drawn from this investigation. **4**

End of Question 28

Marks

Question 29 — Preservatives and Additives (25 marks)

(a) (i) During your study of this option you have undertaken a range of practical experiences that have involved collecting data. **2**

Identify TWO differences between first-hand and secondary-source investigations.

(ii) Danni took some sultanas and placed them in a beaker of water. After one hour, Danni noticed that the sultanas were swollen. **2**

Explain why the sultanas became swollen in terms of your understanding of osmosis.

(b) Mieke often makes 'pickled cucumber' for an Indonesian dish. She slices cucumbers very thinly and then places them in a clean bowl containing castor sugar dissolved in vinegar. The bowl of cucumber is then placed in the refrigerator, where it remains fresh for several days.

(i) Justify TWO methods Mieke uses to preserve the cucumber. **3**

(ii) Compare TWO preservation techniques used by different cultures. **3**

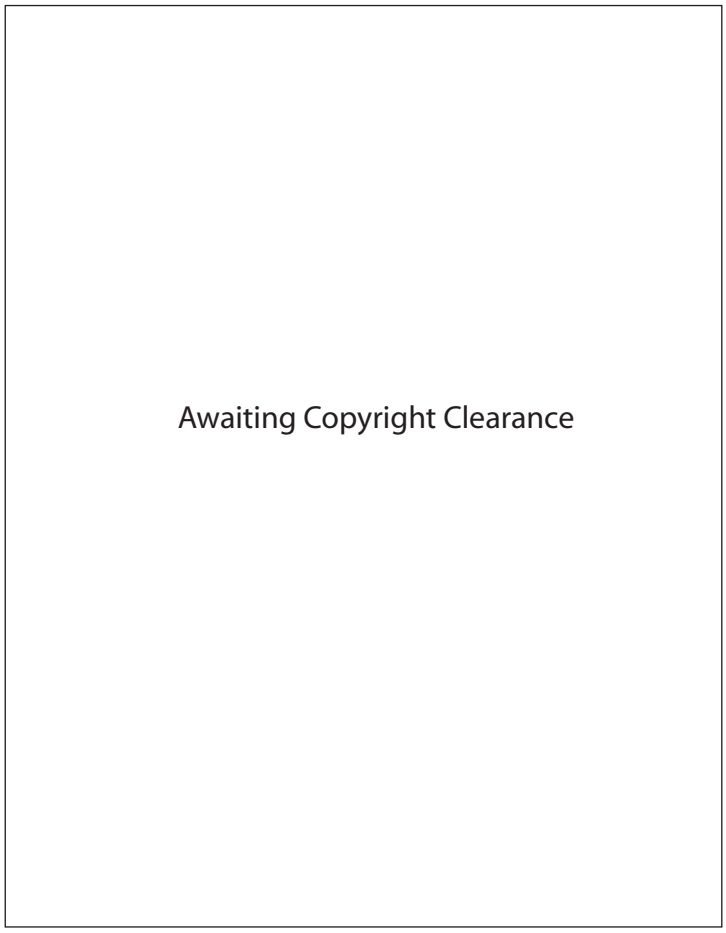
(c) Many Australians are concerned with the large number of preservatives and additives in food.

Assess the advantages and disadvantages to society of using chemical additives and preservatives in our food. **7**

Question 29 continues on page 25

Question 29 (continued)

(d) Marmalades are jams containing citrus fruits and usually have lemon or orange peel suspended in the mixture. Citrus fruits are rich in pectin, so that the jam will set.



(i) Name ONE natural preservative in the above recipe, and describe its function. **2**

(ii) Justify the need for hot, sterilised jars and prompt sealing of home-made jams. **3**

(iii) Commercial jams are made from the same ingredients, but often have the preservative potassium metabisulfite (223) added to them. Home-made jams continue to be made safely without any artificial preservatives. **3**

Discuss the addition of metabisulfite to commercial jams.

End of Question 29

Marks

Question 30 — Pharmaceuticals (25 marks)

(a) (i) During your study of this option you have undertaken a range of practical experiences that have involved collecting data. **2**

Identify TWO differences between first-hand and secondary-source investigations.

(ii) This is a photomicrograph of human blood. **2**

Identify *X* and describe its role.

(b) The circulatory system can be used to transport many pharmaceutical substances.

(i) Construct a table that summarises the structure and function of: **3**

- arteries
- veins
- capillaries.

(ii) Describe the roles of the digestive system and the circulatory system acting together to transport pharmaceuticals around the body. **3**

Question 30 continues on page 27

Question 30 (continued)

(c) Lister, Pasteur and Koch all made contributions to our understanding of disease. **7**

Analyse the contribution of TWO of these scientists to the development of our current understanding of disease caused by bacteria.

(d) Consider the following report.

> Tony was an enthusiastic gardener but one day sustained a cut on his hand as he was pruning his roses. Instead of washing dirt from his hand immediately and treating the wound, he continued with his gardening until the work was completed.
>
> The next day Tony started to experience some pain from the wound and as time passed, he observed the following physiological responses:
>
> 1. Pus formed in the tissue on the edge of the wound.
> 2. The area surrounding the wound began to swell.
> 3. The area surrounding the wound became red.
> 4. The area surrounding the wound felt hot.

(i) Tony responded to the pain of his wound by taking aspirin, an analgesic. Describe how aspirin is able to relieve pain. **2**

(ii) Construct a flow diagram to show the role of prostoglandins in promoting inflammation. **2**

(iii) Identify a possible cause for Tony's physiological responses, and explain how his body was able to respond in the way described. **4**

End of Question 30

Marks

Question 31 — Disasters (25 marks)

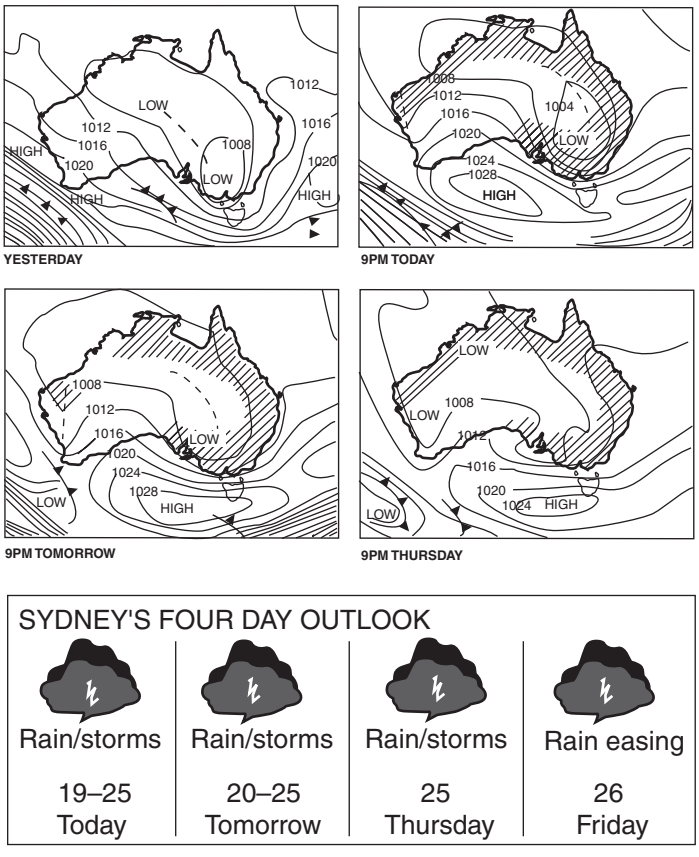
(a) (i) During your study of this option you have undertaken a range of practical experiences that have involved collecting data. **2**

Identify TWO differences between first-hand and secondary-source investigations.

(ii) Many natural disasters have occurred in Australia since 1970. During your course you created a database to present information on these disasters. **2**

List TWO examples of Australian disasters you recorded, and for each describe ONE piece of information you collected for the database.

(b) The following information was published in the Sydney Morning Herald on Tuesday, 7 December 2004.



Question 31 continues on page 29

Marks

Question 31 (continued)

(i) What does the distance between the isobars on the weather maps indicate? **1**

(ii) Explain the reasoning behind the forecasts for Sydney's four-day outlook. **2**

(iii) Explain how information about cloud cover is gathered, and how it has improved our ability to monitor and predict weather patterns. **3**

(c) The consequences of many natural disasters have been made worse by things that people have done or have failed to do in relation to the environment. **7**

Analyse this statement with respect to Australian natural disasters.

Question 31 continues on page 30

Marks

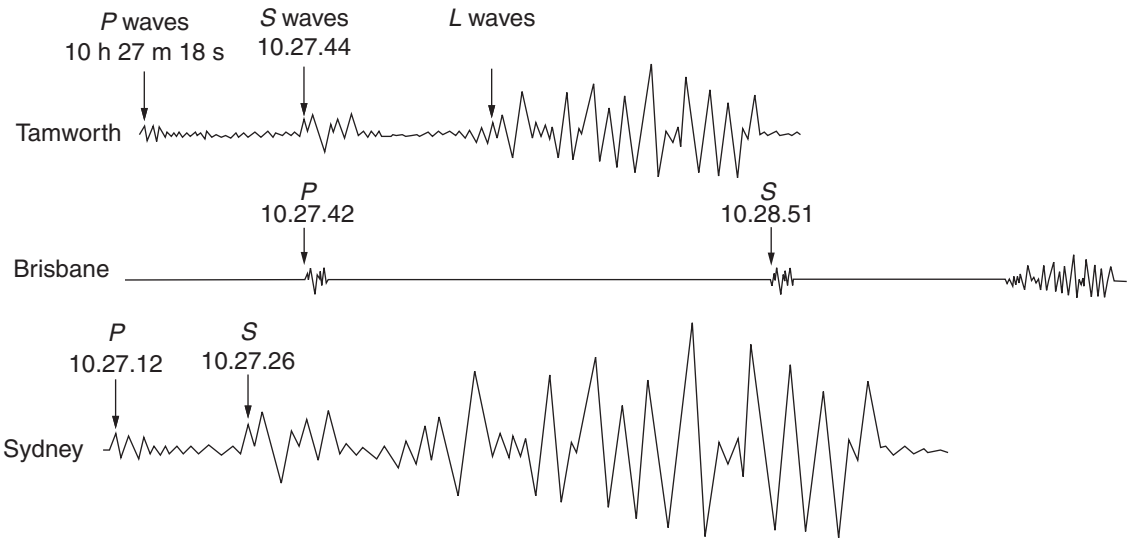
Question 31 (continued)

(d) Predicting earthquakes has been aided by the development of technological devices to record and monitor earth movements. One of these is the seismograph.

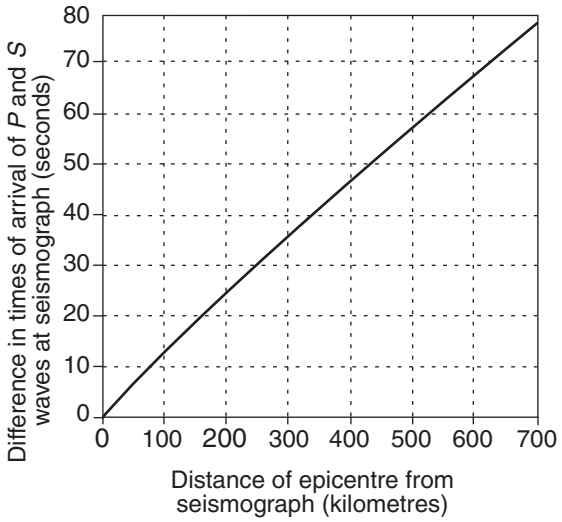
(i) Describe how this device is used in monitoring earth movements. **2**

Use the following information about an earthquake to answer part (d) (ii).

Seismograms



Time–distance graph



B McAllister et al, 1992, Senior Science Book 1, Macmillan Company of Australia, Melbourne, p 138.
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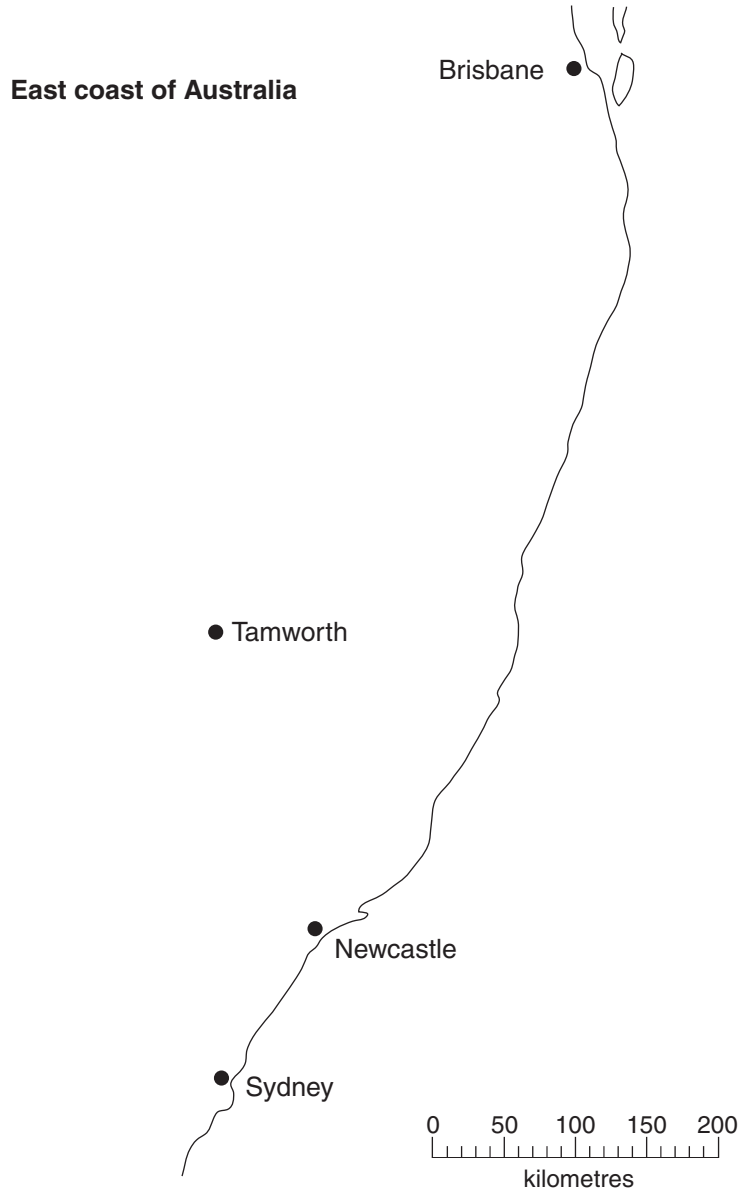
Question 31 continues on page 31

Question 31 (continued)

(ii) Trace the outline of the east coast of Australia into your writing booklet. **6**

Mark the locations of Brisbane, Tamworth, Newcastle and Sydney on your map in your writing booklet.

Use the three seismograms, the time–distance graph and the scale provided to locate the epicentre of this earthquake on the trace of the east coast you made in your writing booklet. (Show ALL working.)



End of Question 31

Marks

Question 32 — Space Science (25 marks)

(a) (i) During your study of this option you have undertaken a range of practical experiences that have involved collecting data. **2**

Identify TWO differences between first-hand and secondary-source investigations.

(ii) Use labelled diagrams to model and compare the relative distances between particles in a solid and in a gas on Earth and in space. **2**

(b) Different methods have been used over time to collect information about our solar system and beyond.

(i) Explain why animals were sent into space before humans. **2**

(ii) Identify TWO current technologies used to probe space, and explain how they provide information to scientists on Earth. **4**

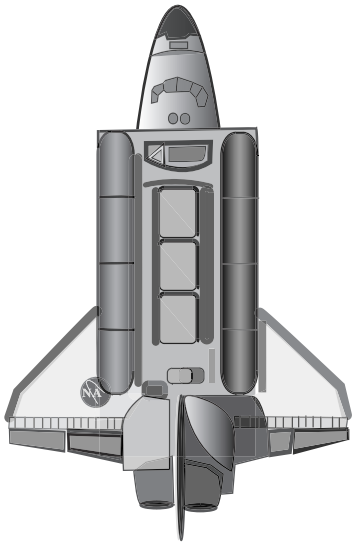
(c) Scientists are currently investigating the short-term and long-term environmental impacts of living in space on human physiology. **7**

Evaluate the scientific findings and current practices that may enable longer space missions for humans.

Question 32 continues on page 33

Question 32 (continued)

(d) Considerable developments in the space exploration program have resulted from the use of the space shuttle.



Reproduced with the permission of spacephotos, Calais, France/s0234.

Data about space shuttle

Mass	2.04×10^6 kg
Length	56 m
Re-entry speed	1100 km/h
Landing speed	360 km/h
Velocity to achieve low-Earth orbit	28 000 km/h

(i) Use data from the table to predict the conditions experienced by the space shuttle on re-entering Earth's atmosphere. **2**

(ii) Relate the properties of materials specifically designed to protect the space shuttle, to the conditions experienced on re-entry. **2**

(iii) This is a photograph of the Voyager I space craft. **4**

Mass	$7.2 \lozenge 10^2$ kg
Overall length of major components	6.1 m

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Voyager I is another aspect of the space exploration program, yet it does not look anything like the shuttle.

Explain the differences in relation to Voyager I's role.

End of paper

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