

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

2009

**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, 17 and 19

Total marks – 100

Section I Pages 2–22

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 23–33

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 for Questions 1–15.

1 Which of the following lists contains only vitamins that are fat-soluble?

- (A) Vitamin A, Vitamin B, Vitamin C
- (B) Vitamin B, Vitamin E, Vitamin K
- (C) Vitamin C, Vitamin D, Vitamin E
- (D) Vitamin D, Vitamin E, Vitamin K

2 What is a characteristic of silicone that makes it suitable for use in bionics?

- (A) It is water resistant.
- (B) It is highly reactive.
- (C) It has high strength.
- (D) It conducts an electric current.

3 What are the properties that make UHMWPE a suitable alternative to cartilage?

	<i>Biocompatibility with surrounding tissue</i>	<i>Friction</i>	<i>Durability</i>
(A)	High	High	High
(B)	Low	Low	Low
(C)	High	Low	High
(D)	High	Low	Low

4 What is a role of microflora on the skin?

- (A) To increase pH on the surface of the skin
- (B) To produce sweat to reduce body temperature
- (C) To produce sebum to reduce water loss
- (D) To combat the growth of disease-causing organisms

- 5 What properties of X-rays make them useful for producing images?
- (A) X-rays are easily reflected and travel at the speed of light.
 - (B) X-rays are absorbed by objects and travel in straight lines.
 - (C) X-rays cannot be absorbed by objects and are high energy radiation.
 - (D) X-rays pass easily through objects but their speed is slowed down by objects.

- 6 The structure of the capillaries surrounding the alveolus is related to their function.

Which of the following correctly identifies this relationship between their structure and their function?

- (A) Thin walls for efficient absorption of O₂ into the capillary
- (B) Thin walls for efficient absorption of CO₂ into the capillary
- (C) Small surface area to volume ratio for efficient absorption of O₂ into the alveolus
- (D) Small surface area to volume ratio for efficient absorption of CO₂ into the alveolus

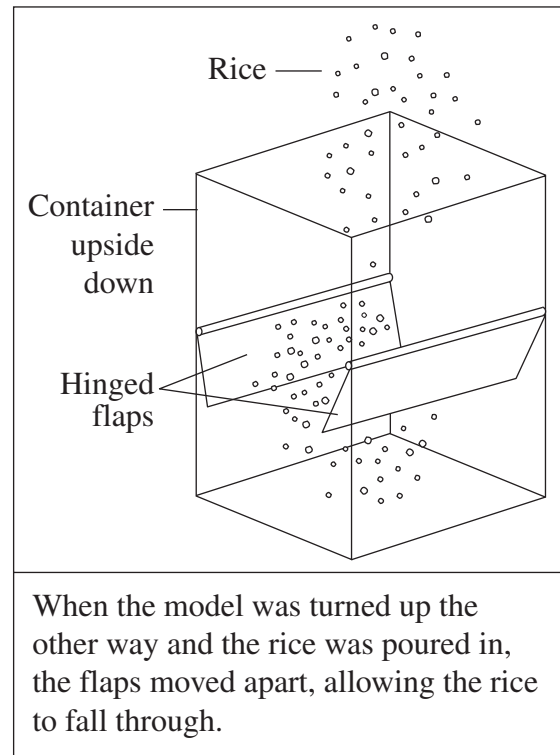
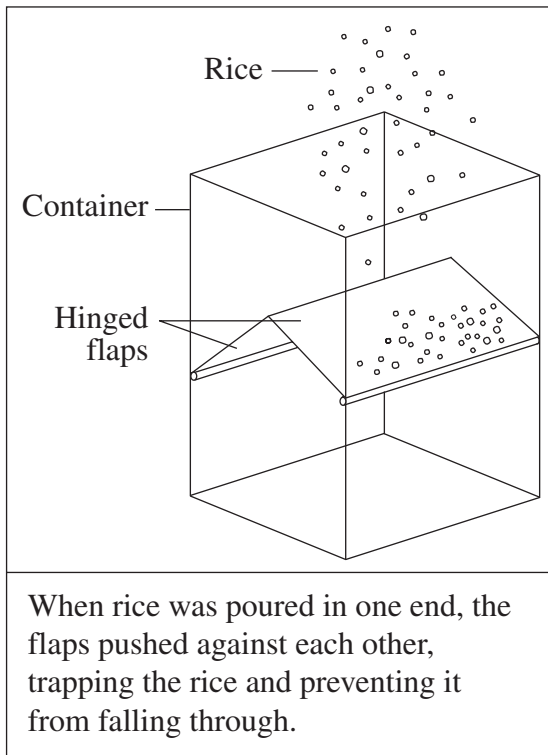
- 7 Which option correctly links the type of electromagnetic radiation to its application?

	<i>Type of electromagnetic radiation</i>	<i>Application</i>
(A)	X-ray	TV remote control
(B)	Gamma ray	Magnetic resonance imaging (MRI)
(C)	Infra-red	Identification of broken bone
(D)	Visible light	CD player

- 8 What is the purpose of adding emulsifying agents to consumer products?

- (A) To reduce the size of solid particles in liquids to form a colloid
- (B) To act as a solvent for chemicals not soluble in water
- (C) To stabilise suspensions of oil–water mixtures
- (D) To reduce the surface tension of oils

9 A student made a model to show the function of a part of the body.



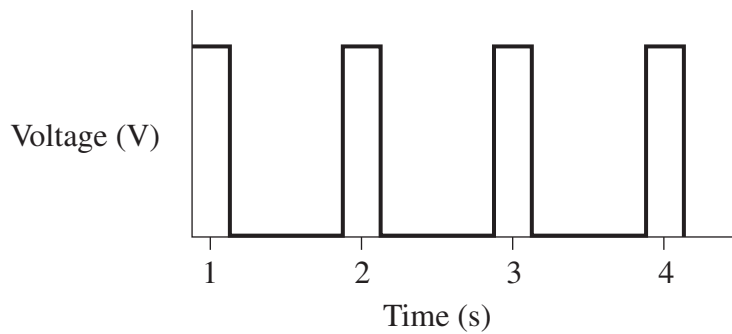
What does this model represent?

- (A) An artery
- (B) A heart valve
- (C) A hinge joint
- (D) A stent

10 Why is a patient's chest compressed during cardio-pulmonary resuscitation (CPR)?

- (A) To expel air from the lungs
- (B) To stimulate the ventricles
- (C) To expel blood from the heart
- (D) To stimulate the sino-atrial node

- 11 This graph shows the electrical signal generated by an everyday device. It shows how voltage changes with time.



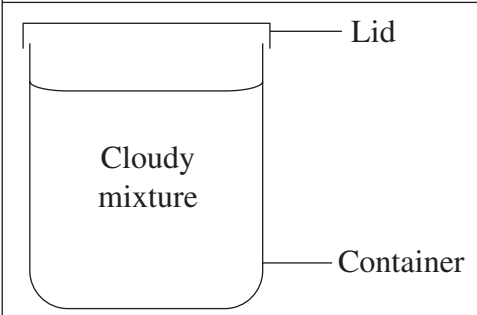
What is the most likely use for this device?

- (A) To stimulate the heart
 - (B) To store digital data on a hard drive
 - (C) To transmit a fax along a copper wire
 - (D) To transmit a signal to an FM radio antenna
- 12 Which option correctly identifies the pH of the three items listed in the table?

	<i>Small intestine</i>	<i>Skin</i>	<i>Shampoo</i>
(A)	9	5	8
(B)	8	5	6
(C)	5	8	6
(D)	3	7	7

- 13 Which list contains types of electromagnetic radiation used in communication systems?
- (A) X-rays, ultraviolet rays, gamma rays
 - (B) Visible light, microwaves, infra-red waves
 - (C) Infra-red waves, visible light, gamma rays
 - (D) Ultraviolet rays, microwaves, radio waves

- 14 Two liquids were mixed together in a closed container and then shaken vigorously. The observations that were made immediately after shaking and two days later are shown.

Observations made	
Immediately after shaking	2 days later
 <p>The diagram shows a rectangular container with a lid. Inside the container, there is a label that says "Cloudy mixture". Lines point from the labels "Lid" and "Container" to the respective parts of the diagram.</p>	<p>There are two separate transparent layers in the container.</p>

What type of mixture was present in the container?

- (A) An emulsion
 - (B) A foam
 - (C) A solution
 - (D) A suspension
- 15 Which terms describe the characteristics of an SMS text message?
- (A) Verbal and electronic
 - (B) Verbal and non-electronic
 - (C) Non-verbal and electronic
 - (D) Non-verbal and non-electronic

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Centre Number

Section I (continued)

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Student Number

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.

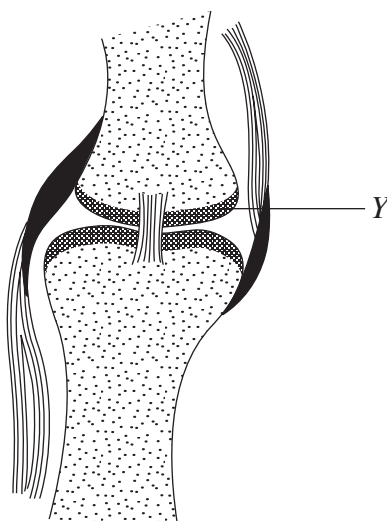
Question 16 (3 marks)

(a) Name ONE synovial joint in the human body.

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(b) A type of synovial joint is shown in the diagram.



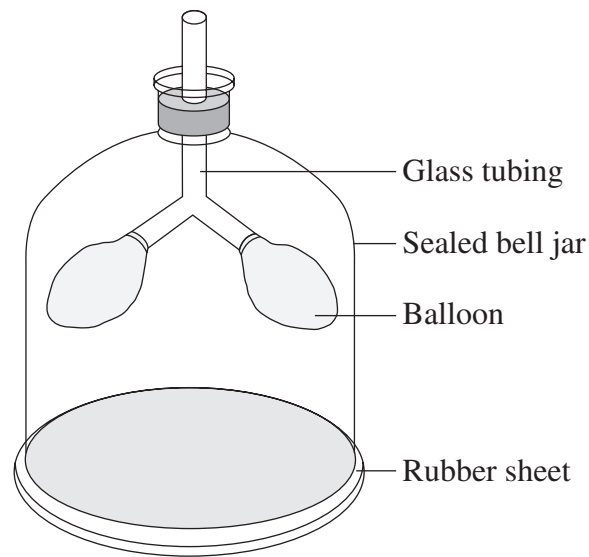
Name the structure labelled *Y* and outline its function.

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Question 17 (4 marks)

The diagram shows a model of part of the respiratory system.



- (a) Explain the effect of pulling down on the rubber sheet. 2

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- (b) Outline why models, such as the one shown, are used in science. 2

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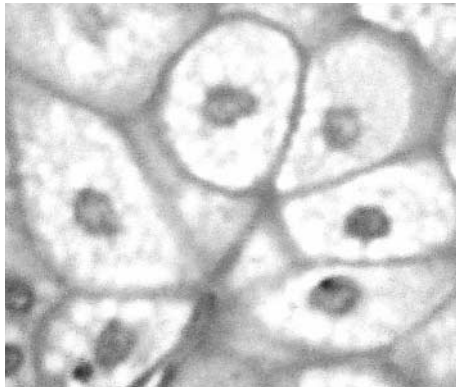
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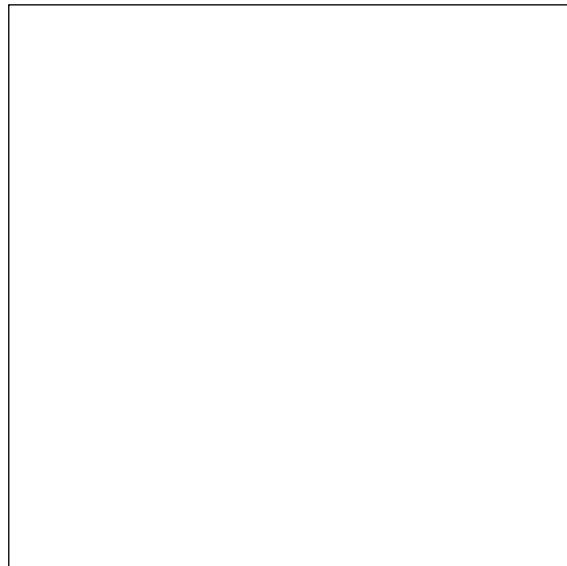
Question 18 (6 marks)

- (a) A slide of human skin that was photographed through a microscope is shown.



Draw a scientific diagram to represent skin cells as photographed through the microscope.

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- (b) Surgery is considered a risk because it interferes with an important role of the skin.

3

Explain how this risk can be reduced.

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Question 19 (4 marks)

The following information refers to the transmission of data.

Data security

Computer data is transmitted through optical fibres and copper wires as digitally encoded information. As a result of the encoding system, only the person who is meant to receive the message is able to decode the information.

Digital signals travelling through a copper wire can be detected by attaching an external device around the wire.

It is not possible to detect digital signals travelling through optical fibres from outside the fibre.

Data transfer rate comparison

	<i>Information transfer rate (megabits/second)</i>
Copper wire	1.5
Optical fibre	2500

Is it better to use copper wires or optical fibres to transmit large amounts of data securely? Use the information provided to justify your answer.

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Centre Number

Section I – Part B (continued)

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Student Number

Question 20 (6 marks)

Describe the beneficial and detrimental effects of soaps and soapless detergents on the environment.

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Question 21 (6 marks)

Kim is attached to a monitor that measures heart rate and breathing rate. He begins to run. Readings are taken every thirty seconds during the first four minutes of running.

The results are shown in the table.

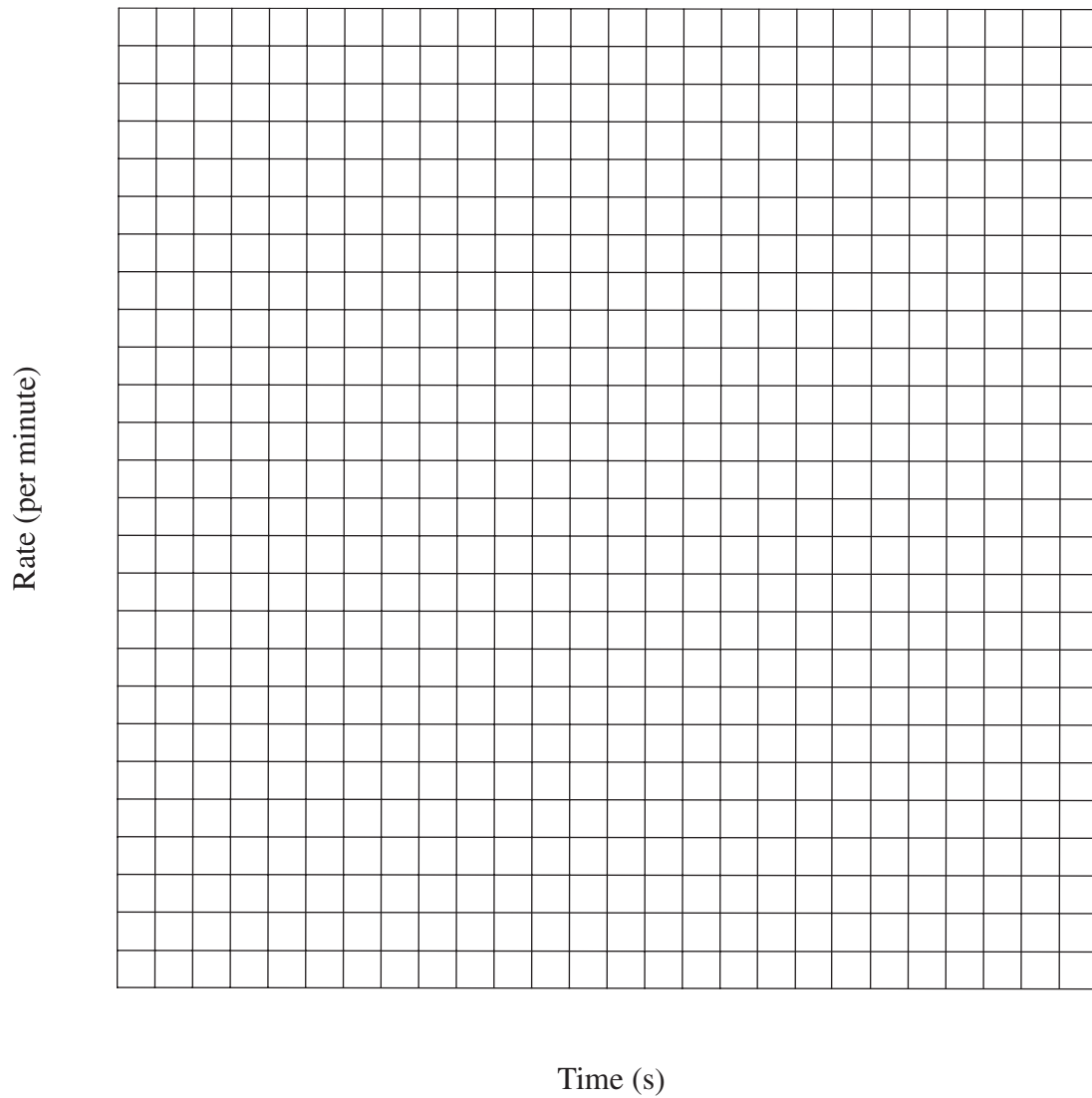
<i>Time (s)</i>	<i>Heart rate (beats per minute)</i>	<i>Breathing rate (breaths per minute)</i>
0	60	12
30	65	15
60	75	20
90	80	28
120	85	35
150	92	37
180	105	40
210	112	42
240	120	42

Question 21 continues on page 15

Question 21 (continued)

- (a) Graph both the heart rate and breathing rate against time.

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- (b) Account for the trend observed in Kim's heart rate while he was running.

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End of Question 21

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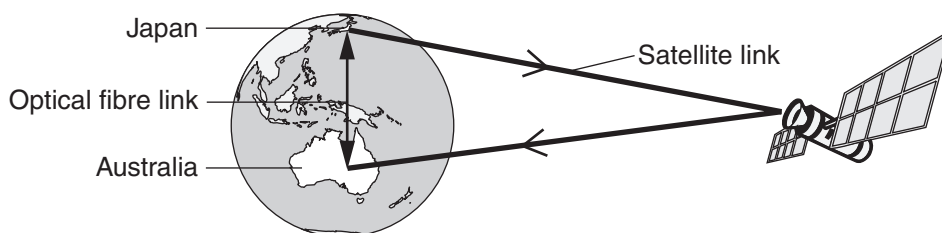
Section I – Part B (continued)

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Student Number

Question 22 (4 marks)

Two communications systems that allow people in Japan and Australia to talk to each other are satellite links and optical fibre links.



The satellite link uses waves that travel through space at 300 000 km/s.

The distance from the satellite to both Japan and Australia is 36 000 km.

Speed is calculated using the formula: $\text{speed} = \frac{\text{distance}}{\text{time}}$

- (a) Calculate the time it would take a signal to travel from Japan to the communications satellite. 2

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- (b) The optical fibre link allows a signal to travel in either direction between Japan and Australia in 0.05 seconds. 2

What are the advantages of using the optical fibre link rather than the satellite link for people in Japan and Australia to talk to each other?

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Question 23 (4 marks)

A student carried out this investigation:

1. 100 mL of water was placed in a clean beaker.
2. A clean dropper was filled with water from the beaker.
3. 40 drops were needed to reach the 1 mL mark in a clean measuring cylinder.
4. 5 drops of detergent were added to the water in the beaker and mixed well.
5. The same dropper was re-filled with the mixture from the beaker.
6. 60 drops were needed to reach the 1 mL mark in another clean measuring cylinder.

(a) What is the dependent variable in this investigation? **1**

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(b) What is one way the student ensured that the results were valid? **1**

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(c) Explain how the addition of detergent changes the behaviour of water in this investigation. **2**

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Centre Number

Section I – Part B (continued)

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Student Number

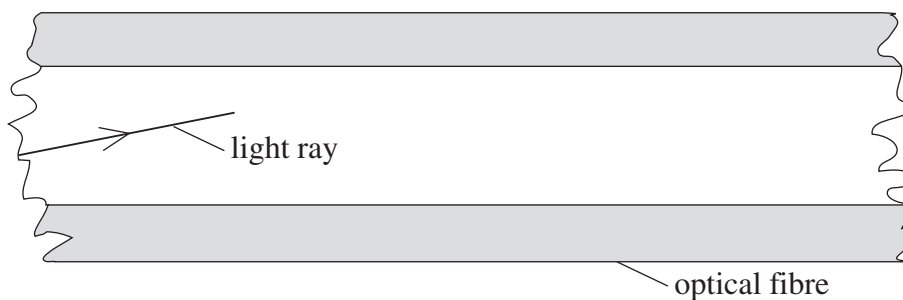
Question 24 (4 marks)

- (a) Identify TWO properties of optical fibres that make them suitable for use in communication systems and medical endoscopes. **2**

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- (b) Complete this diagram to show the path of the light ray through the optical fibre. **2**



Question 25 (8 marks)

- (a) Scientific ideas have enabled technological advances in areas such as medicine and communications.

For each example in the table, clearly show how a scientific idea relates to the technology.

<i>Technology</i>	<i>Scientific idea and how it relates to the technology</i>	
Prosthetic limbs	2
AM/FM radio	2
Subdermal implants	2

- (b) Explain how a possible future direction in scientific research could lead to an improvement in ONE technology identified in the table. **2**

Technology:

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Question 26 (5 marks)

Tracy had a pacemaker fitted when she was 16 years old. Five years later she is having problems with digestion in her small intestine. The doctor could use X-ray, ultrasound or magnetic resonance imaging (MRI) to diagnose digestion problems.

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Evaluate the suitability of each of these methods for diagnosing Tracy’s problems.

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Senior Science

Section II

25 marks

Attempt ONE question from Questions 28–32

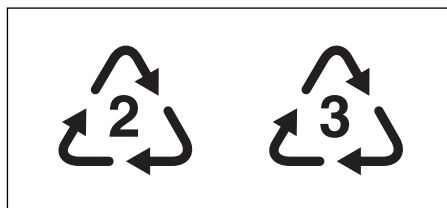
Allow about 45 minutes for this section

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

	Pages
Question 28 Polymers	24–25
Question 29 Preservatives and Additives	26–27
Question 30 Pharmaceuticals	28–29
Question 31 Disasters	30–31
Question 32 Space Science	32–33

Question 28 — Polymers (25 marks)

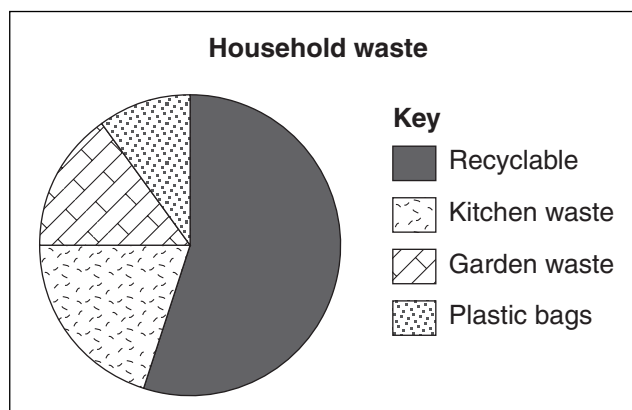
- (a) Symbols used as labels on polymers are shown.



- (i) What do the numbers and arrows in symbols such as these indicate? **2**
- (ii) Additives, such as stabilisers, account for up to 60% of the weight of items made of PVC. **2**

How viable is the recycling of PVC items?

- (b) The pie graph shows some types of household waste in Australia. **3**



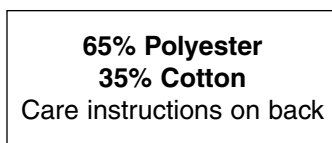
Construct a table to record the percentage for each type of household waste in Australia as shown in the pie graph.

- (c) Identify a thermoset plastic that could be found in household waste. **1**

Question 28 continues on page 25

Question 28 (continued)

- (d) The following diagram shows information on a shirt label.



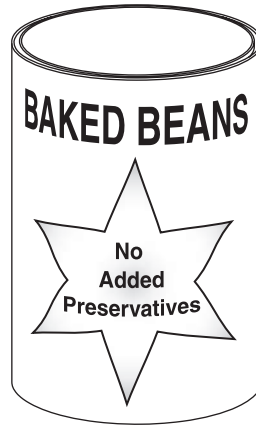
- (i) Outline properties of the synthetic polymer listed on the clothing label. **2**
- (ii) Using an example, explain why manufacturers blend natural and synthetic polymers when producing fabrics for clothing. **3**
- (e) Define the term *decomposer* and state why decomposers are vital in ecosystems. **2**
- (f) Scientists are working to produce completely biodegradable synthetic polymers. **3**
- Outline the features of a first-hand investigation these scientists could use to determine the impact of biodegradable synthetic polymers on the environment.
- (g) It has been proposed that the manufacture of all synthetic polymers be banned because of a future shortage of petrochemicals. **7**

Assess the impact of such a ban on everyday life.

End of Question 28

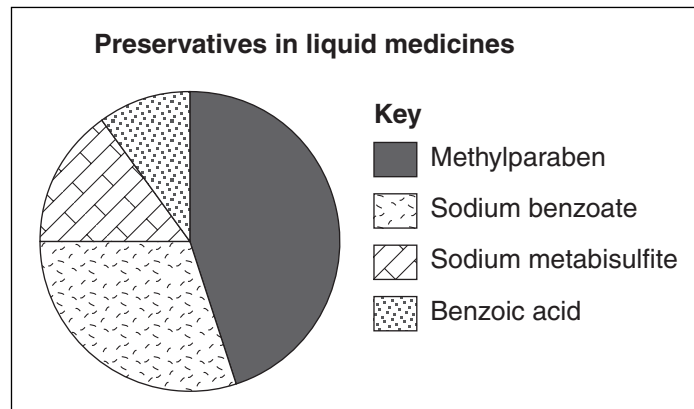
Question 29 — Preservatives and Additives (25 marks)

(a) A canned food product is shown.



- (i) Identify the type of advertising used on the label of this food product. **1**
- (ii) Why is the claim made on this label inappropriate? **3**

(b) The pie graph shows preservatives used in liquid medicines. **3**



Construct a table to record the percentage for each preservative as shown in the pie graph.

(c) Identify a natural preservative used in food. **1**

Question 29 continues on page 27

Question 29 (continued)

(d) The following photographs show examples of two food preservation methods.



- (i) Outline a similarity and a difference in the preservation methods used in the examples shown. **2**
- (ii) What impact have these types of food preservation methods had on society? **3**
- (e) (i) Identify a human allergic response to a food and state its treatment. **2**
- (ii) Outline the features of a first-hand investigation a scientist could use to safely confirm the specific food that caused a person's allergic response. **3**
- (f) Our scientific understanding of food spoilage has improved over time. How has this led to safer methods of food preparation? **7**

End of Question 29

Question 30 – Pharmaceuticals (25 marks)

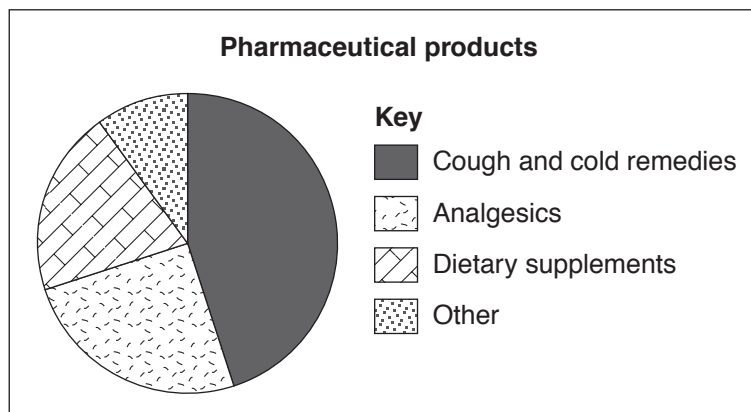
(a)



(i) Name the type of bacterium shown in the photograph. **1**

(ii) Describe the process of reproduction in bacteria. **3**

(b) The pie graph shows pharmaceutical products sold in Australia in 2008. **3**



Construct a table to record the percentage for each pharmaceutical product as shown in the pie graph.

(c) Identify ONE example of an analgesic. **1**

Question 30 continues on page 29

Question 30 (continued)

- (d) (i) Outline ONE similarity and ONE difference between an artery and a vein. **2**
- (ii) How does William Harvey's model of blood circulation described below explain the distribution of an injected pharmaceutical in the body? **3**

William Harvey's model of human blood circulation, 1628

Blood is pumped around the body by the heart in two closed loops. In one loop, blood travels from the heart to the lungs, then back to the heart. In the other loop, the blood flows to the body tissues and then returns to the heart. The blood is re-used and re-circulated, not continually made new by the liver and heart.

This model was based on data such as counts of the number of heartbeats in 30 minutes, and estimates of the amount of blood expelled by each pump of the heart.

- (e) (i) Name ONE antibiotic other than penicillin and identify its source and mode of action. **2**
- (ii) Outline the features of a first-hand investigation that scientists could use to determine the types of bacteria killed by this antibiotic. **3**
- (f) How has scientific knowledge of inflammation and synapses allowed a better understanding of the effects of analgesics on the body? **7**

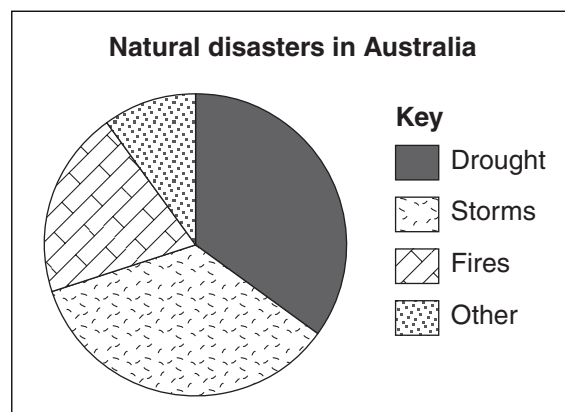
End of Question 30

Question 31 — Disasters (25 marks)

- (a) The following information relates to two natural disasters that occurred in 2008.

More than 90 percent of the 235 816 people killed in natural disasters in 2008 died during Burma's cyclone and China's earthquake.

- (i) Why are the cyclone in Burma and the earthquake in China described as *natural disasters*? **2**
- (ii) Identify the location and year of a specific natural disaster that has occurred in Australia since 1970. **2**
- (b) The pie graph shows natural disasters in Australia in 2008. **3**



Construct a table to record the percentage for each disaster as shown in the pie graph.

- (c) Identify ONE example of an Australian disaster caused by human activity. **1**

Question 31 continues on page 31

Question 31 (continued)

(d) The following information is from a home building insurance policy:

If your home or contents suffer loss or damage caused by

- a violent wind, cyclone or tornado, or
- thunderstorm or hail which may be accompanied by rain or snow, or
- a sudden, excessive run-off of water as a direct result of a storm in your local area

then we will rebuild or repair that part of your home that was damaged, unless it was not kept in good order and repair, that is, it was not structurally sound or well maintained.

We will not cover loss or damage caused when water enters through an opening that was not created by the storm.

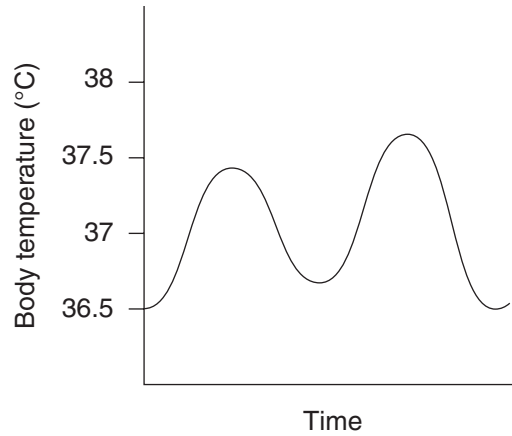
- (i) Under what circumstances would this insurance company repair or rebuild the home of a policy holder? **2**
- (ii) During a thunderstorm, water entered a house through a window that had been left open, and caused damage to the floor. Would the insurance company pay compensation for this damage? Use the policy to justify your answer. **3**
- (e) What does it mean when isobars are close together on a weather map? **2**
- (f) How has ONE improvement in weather forecasting technology reduced the loss of life in natural disasters? **3**
- (g) It has been suggested that there should be a national disaster warning system that sends text messages to mobile phones. **7**

Assess the effectiveness of such a system for warning people about impending disasters.

End of Question 31

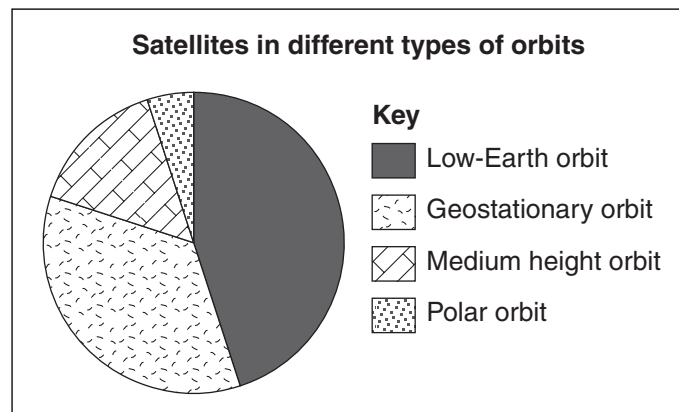
Question 32 — Space Science (25 marks)

(a) This graph shows variation in human body temperature with time.



- (i) With reference to this graph, outline the meaning of the phrase *circadian rhythm*. **2**
- (ii) Identify TWO activities that would disrupt a person's circadian rhythms. **2**

(b) The pie graph shows satellites in different types of orbits. **3**



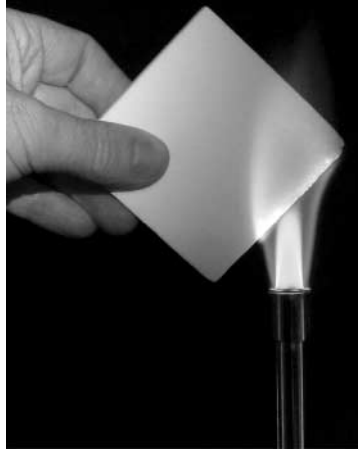
Construct a table to record the percentage for each type of orbit as shown in the pie graph.

(c) Identify a space station currently in use. **1**

Question 32 continues on page 33

Question 32 (continued)

- (d) The material held in the Bunsen burner flame in the photograph is used to make the tiles for the outside of the space shuttle. A person is holding the material just a few centimetres from where it has been heated to white-hot temperatures.



- (i) Identify the property of the tile that allows it to be safely held in the Bunsen burner flame as shown in the photograph. **1**
- (ii) Relate TWO properties of these tiles to their role when the space shuttle is re-entering the Earth's atmosphere. **4**
- (e) Space suits protect astronauts from the conditions in space. **2**
- Identify TWO of these conditions.
- (f) Voyager 2 travelled out of the solar system from Earth, a journey that took several years. **3**
- A newspaper report stated: 'Voyager 2 travelled through millions of kilometres of empty space during its journey.'
- Assess this statement.
- (g) Four hundred years ago, Galileo was the first person to use a telescope to observe the behaviour of sunspots. **7**

Describe some developments since Galileo's time, in telescopes and other technologies, which have allowed scientists to gather information about the universe.

End of paper

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