BOARD OF STUDIES
NEW SOUTH WALES

2004

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, 15 and 17

Total marks – 100

Section I Pages 2–20

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 21–32

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.

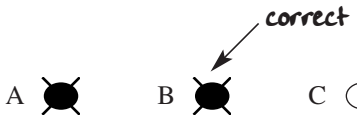
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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 exposed surface of water tends to contract into the smallest possible area because of unequal cohesive forces between water molecules at its surface.

Which of the following results from this phenomenon?

(A) Water taking the shape of its container

(B) The solubility of alcohol compounds in water

(C) The ability of insects and spiders to walk on water

(D) The shape of the meniscus depends on the depth of water in its container.

2 Substances are biodegradable if they can be eaten or otherwise decomposed by living organisms, such as bacteria and fungi.

Why is it important in today's world for detergents to be biodegradable?

(A) A detergent is more effective in cleaning plates if it is non-biodegradable.

(B) Biodegradable detergents are able to kill bacteria and fungi before they choke the waterways.

(C) Non-biodegradable detergents could build up in natural waterways and cause significant and long-term damage.

(D) Biodegradable detergents maintain food chains in natural waterways by supplying the necessary food sources for bacteria and fungi.

3 Migraine headaches are a serious problem for many people and can last for periods up to several days.

Some drugs can be used as tablets to relieve pain and restore normal function during migraine attacks. What characteristic is essential for these drugs to be effective?

(A) Cost

(B) Alkaline pH

(C) Absorption in the mouth

(D) Solubility in body fluids

4 Marilyn and Colin studied body soap. They examined the label on a soap. They classified four substances listed on the label as follows.

	Substance	*Type of substance*	*Purpose*
W	EDTA	Preservative	Prevents decay of body soap through bacterial attack
X	Glycerin	Enzyme	Brightens the skin
Y	Sodium stearate	Acidifying agent	Increases pH of the body soap to match the pH of the skin
Z	Water	Emulsifying agent	Inhibits growth of the micro-organisms that cause odour or disease

Which row in the table above correctly relates the substance to its type and purpose?

(A) *W*

(B) *X*

(C) *Y*

(D) *Z*

5 Medications labelled 'for external use only' are often manufactured in water-based creams. Given that many medications used on the skin are toxic internally, which of the following considerations justifies water as the solvent?

(A) Drugs are soluble in water.

(B) Drugs are not soluble in water.

(C) The skin surface is easily penetrated by water.

(D) The skin surface is not readily penetrated by water.

6 Which one of the following materials would be the most suitable for use in a hip replacement?

(A) Silicone polymer

(B) Titanium alloy

(C) Teflon plastic

(D) Iron metal

7 What is the function of an artificial pacemaker?

(A) It controls the metabolic rate.

(B) It regulates blood flow to the heart.

(C) It sends electrical impulses to the heart muscle.

(D) It relays nerve impulses from the brain to the heart.

8 The human spine is composed of vertebrae with discs of cartilage in between. What is the main function of these discs?

(A) To act as shock absorbers

(B) To glue the spine together

(C) To attach muscles to the spine

(D) To connect the spinal cord to the brain

9 Cardiopulmonary resuscitation (CPR) is a combination of expired air resuscitation (EAR) and external cardiac compression (ECC).

What is the main purpose of carrying out CPR on a person whose heart has stopped beating?

(A) To re-start the heartbeat

(B) To remove oxygen from the blood

(C) To establish normal breathing patterns

(D) To provide oxygenated blood to the brain

10 There are a number of different non-invasive, or minimally invasive, techniques that can be used in diagnostic medicine.

Which of the following statements correctly identifies the advantage of one of these techniques?

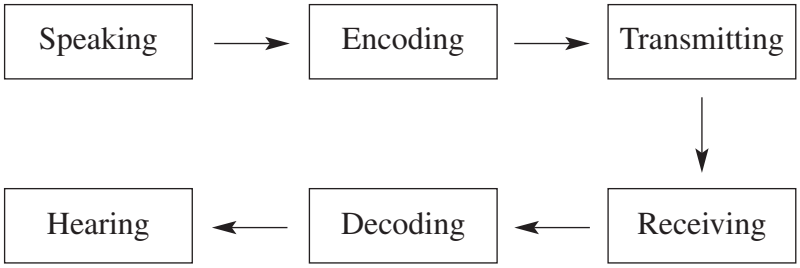
(A) Keyhole surgery does not allow micro-organisms to enter the body through a cut in the skin.

(B) Thermography does not subject the body to radiation but measures heat emitted from the body.

(C) Ultrasound uses electromagnetic radiation to detect moving objects in the body.

(D) X-ray images may be taken frequently without any side effects.

11 The diagram represents the stages in the transmission of information by a mobile phone.



The type of energy used to carry the message changes at different stages during its transmission.

At which stage is the energy carrying the message transformed from electromagnetic energy to electrical energy?

(A) Encoding

(B) Transmitting

(C) Receiving

(D) Decoding

12 Which part of the electromagnetic spectrum carries television programs to people's homes?

(A) Infra-red radiation

(B) Radio waves

(C) Sound waves

(D) Visible light

13 A satellite dish must be installed at home to receive satellite television signals. What is a requirement for the dish to receive these signals?

(A) It must be able to move because the satellite orbits Earth from east to west.

(B) It must be able to move because the satellite is stationary and Earth is rotating beneath it from west to east.

(C) It must be stationary because Earth and the satellite are not moving.

(D) It must be stationary because the satellite's period of revolution is the same as Earth's rotation.

14 A group of students used a light sensor connected to a data logger to investigate how the brightness of light changes at different distances from an electric light globe. They recorded their results in a table.

Distance (m)	*Brightness of light* (lux)
1	417
2	104
3	45
4	25

Which of the properties of electromagnetic waves used in communication systems can be explained by the results of this experiment?

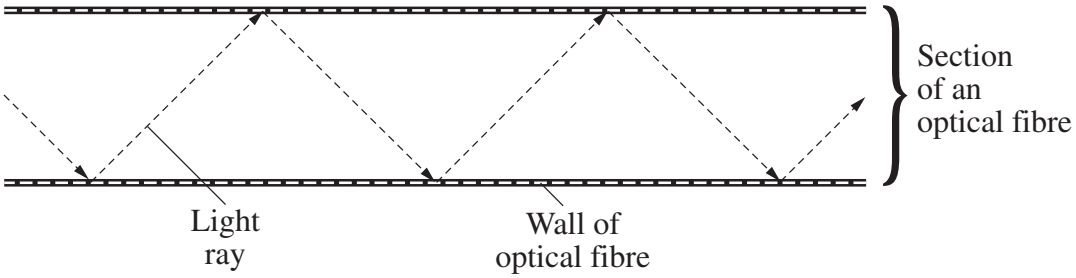
(A) Microwaves travel in straight lines.

(B) The signal is stronger closer to the radio transmitter.

(C) Electromagnetic radiation travels faster than sound waves.

(D) Short-wave radio waves can be reflected off the ionosphere and received on the opposite side of the world.

15 This diagram shows a possible light path as it passes through an optical fibre, demonstrating the principle of total internal reflection.



What advantage does this principle give to optical fibres when compared to copper cables?

(A) Greater efficiency because there is minimal loss of signal

(B) Greater security because it is difficult to connect with the signal

(C) Greater carrying capacity because the optical fibre is made of glass

(D) Greater speed because the light is able to bounce off the inner walls of the optical fibre

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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 (4 marks)

During your course you analysed information to identify some types of chemicals used in everyday living, including pesticides, detergents, lubricants, solvents and cosmetics. **4**

In the table, the use and safety precautions that may be needed in the handling of chemicals have been shown for ONE type of chemical.

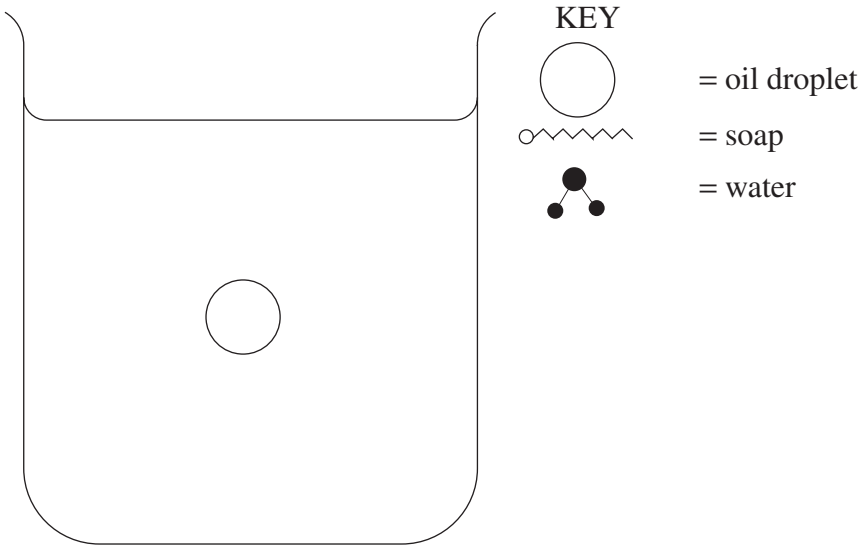
Complete the table for TWO of the other types of chemicals.

Type of chemical	*Use*	*Safety precaution*
Pesticide	Controls pests in crops	Do not spray in strong winds

Marks

Question 17 (2 marks)

Soaps, skin cleanser and shampoos all affect the solubility of oils in water. Use the symbols provided to complete the diagram, to show how the soap, water and oil droplet interact. **2**



Question 18 (5 marks)

(a) The skin of our bodies has a natural pH. This pH is influenced by factors such as natural oil produced by glands in the skin, microflora on the skin and perspiration. **3**

Describe how these THREE factors contribute to the pH of the skin.

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(b) Explain the relationship between the pH of skin products and the pH of a person's skin. **2**

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Marks

Question 19 (4 marks)

A group of students was investigating colloids. They downloaded a recipe for mayonnaise from the internet but discovered that the volume of one ingredient, the olive oil, could not be read.

Ingredients

3 egg yolks

1 heaped tablespoon mustard

2 tablespoons white wine vinegar

***mL olive oil

Salt and pepper

Procedure

- In a food processor, or mixer, combine egg yolks, mustard, vinegar and salt and pepper.
- Add olive oil in a slow steady stream.

(a) Identify the THREE ingredients from this recipe that are included to produce the colloid. **1**

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(b) Describe an investigation the students could conduct to determine the correct volume of olive oil needed to make the colloid. **3**

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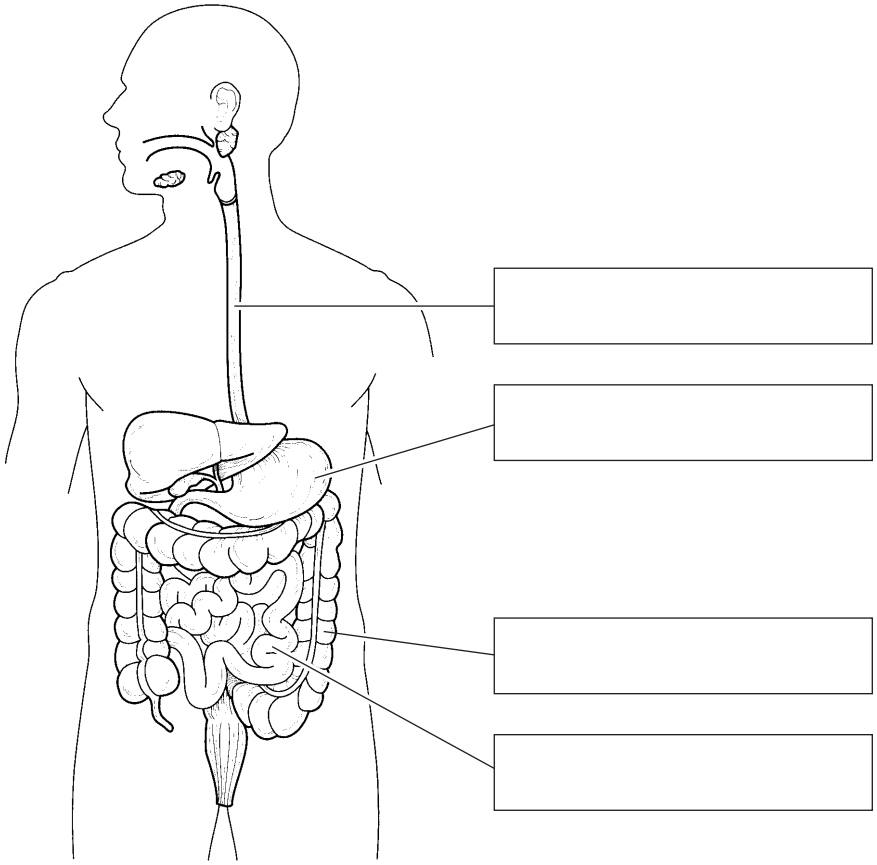
Marks

Question 20 (5 marks)

(a) Identify the following labelled parts of the digestive system. **2**



(b) Explain how the difference between the pH of the stomach and the pH of the small intestine affects the breakdown of food. **3**

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Marks

Question 21 (3 marks)

One of the main causes of heart disease is the build-up of plaque in the walls of major arteries.

(a) Outline the effect plaque has on blood flow. **1**

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(b) Describe TWO techniques used to overcome the effects of plaque build-up. **2**

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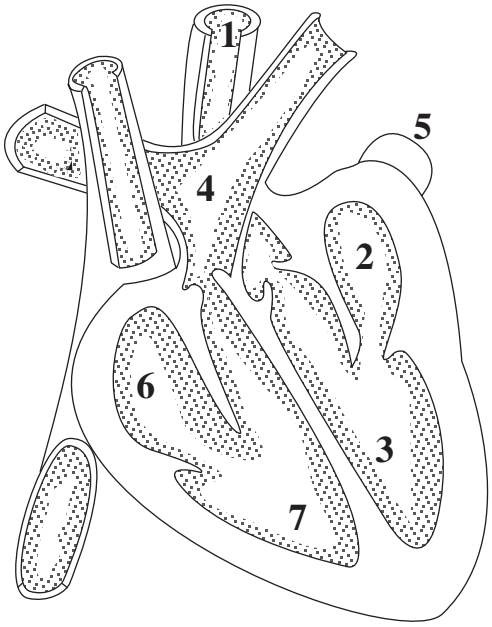
Please turn over

Marks

Question 22 (6 marks)

This is a diagram of a human heart.



1 — Aorta
2 — Left atrium
3 — Left ventricle
4 — Pulmonary arteries
5 — Pulmonary veins
6 — Right atrium
7 — Right ventricle

(a) On the diagram, use arrows to show the direction of blood flow through the heart. **1**

(b) Describe the function of the valve between the left atrium and the left ventricle. **1**

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(c) Describe the function of each of the four chambers of the heart. **4**

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Marks

Question 23 (5 marks)

The following is an X-ray of a human joint.

(a) Write the letter that identifies: **1**

(i) cartilage; .....

(ii) synovial fluid location. .....

(b) Identify the type of synovial joint shown in the diagram. **1**

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(c) Describe THREE properties of ultrahigh molecular weight polyethylene (UHMWPE) that make it a suitable alternative to cartilage in the joint. **3**

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Marks

Question 24 (6 marks)

Carbon dioxide is in the air that you breathe into your lungs (inhale) and also in the air that you breathe out of your lungs (exhale).

(a) Outline a test you have used to demonstrate the presence of carbon dioxide in air. **1**

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(b) Describe a procedure you have used to compare the concentration of carbon dioxide in exhaled air with the concentration of carbon dioxide in inhaled air. **2**

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(c) Explain why the concentration of carbon dioxide in exhaled air differs from the concentration of carbon dioxide in inhaled air. **3**

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Centre Number

Student Number

Section I – Part B (continued)

Marks

Question 25 (8 marks)

(a) Identify ONE property of energy from the electromagnetic spectrum that makes it useful in communication technologies. **1**

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(b) In your study of Information Systems, you investigated the quality of reception of AM and FM radio waves. Describe how you measured the 'quality' of reception, and the equipment you used to carry out this investigation. **3**

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Question 25 continues on page 18

Marks

Question 25 (continued)

(c) Construct a table summarising the findings of your investigation on AM and FM radio transmissions. Outline your conclusion. **4**

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Question 26 (5 marks)

(a) High-definition digital television is a new form of digital technology being introduced into Australia. Describe ONE benefit of this form of digital technology. **1**

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Question 26 continues on page 19

Question 26 (continued)

(b) Digital scanning of an input image along a very thin line results in coding of a section of the image into a series of zeros and ones at regular time intervals. **2**

A short sequence of binary code representing changes in the digital signal is shown in Table 1.

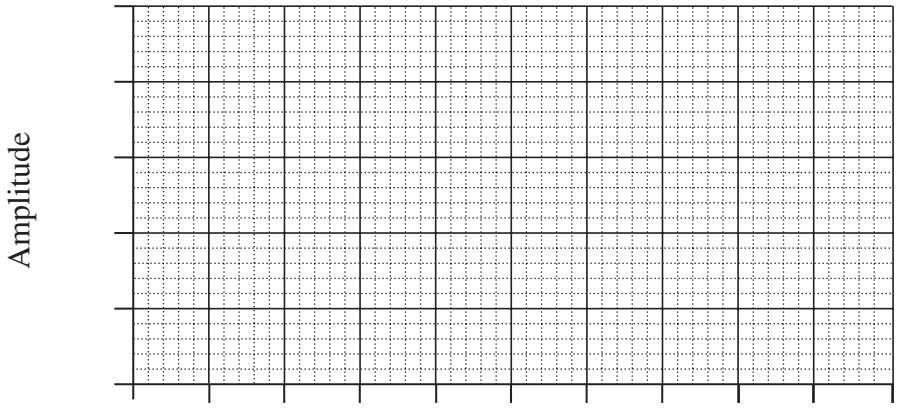
Table 1: Digital signal data

Time intervals	*Binary codes*
0–1	00000
1–2	00001
2–3	00000
3–4	00000
4–5	00001
5–6	00001
6–7	00000
7–8	00000
8–9	00001
9–10	00000

Table 2: Binary code translator

Binary code	*Amplitude of the signal*
00000	0
00001	1
00010	2
00100	4

Use the information in Table 1: Digital signal data, and Table 2: Binary code translator, to draw a graph of the changes of amplitude of this signal with time.



(c) Describe how the digital coding of the scanned image in part (b) allows it to be transmitted and decoded. **2**

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End of Question 26

Marks

Question 27 (7 marks)

Identify when TWO communication systems were developed during the last 200 years, by writing the names of each system on the timeline below. **7**

Analyse the impacts of each of these systems on society.

Timeline (last 200 years)

Analysis of impact

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)

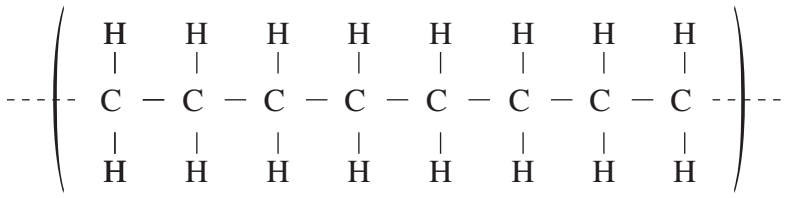
(a) (i) Cotton, lycra, PVC and silk are all polymers. Identify which of these polymers are synthetic. **1**

(ii) Using ONE example of a polymer from the list above, relate TWO uses of this polymer to its properties. **3**

(b) (i) Identify TWO naturally occurring raw materials that can be used to manufacture synthetic polymers. **2**

(ii) Polyethylene is a synthetic polymer.

This is a section of a polyethylene molecule.



(1) Identify the basic monomer or chemical unit used to make this polymer. **1**

(2) Identify a use for this polymer, and describe TWO properties that make it suitable for this purpose. **3**

(c) Analyse the benefits and problems involved in recycling plastic materials. In your answer, consider the impact of biodegradability, downcycling and the uses of recycled plastic materials. **7**

(d) (i) The discovery and use of plastic substances has had an important impact on society. Discuss, using examples, TWO ways plastics have impacted on society. **3**

(ii) In your study of polymers you carried out a first-hand investigation of the effects of temperature on different polymers. Write a scientific report of your investigation, including the procedure, and use your results to justify your conclusions. **5**

Marks

Question 29 — Preservatives and Additives (25 marks)

(a) The article below describes developments in techniques used to preserve food.

Awaiting Copyright Clearance

(i) Appert incorrectly believed that food was spoilt by a substance he called 'ferment'. From your knowledge of preservatives and additives, identify ONE cause of food spoilage. **1**

(ii) Appert's method for preserving food was successful. Identify TWO steps in Appert's process, and explain why these steps lead to the successful preservation of food. **3**

Question 29 continues on page 24

Marks

Question 29 (continued)

(b) Most unprocessed foods contain acids and can be classified as 'high acid' or 'low acid' foods.

The pH of 4.5 is critical in food processing because, below this pH *Clostridium botulinum*, the most dangerous and heat resistant of the food-poisoning bacteria, is unable to grow.

Foods with a pH above 4.5 require pressure cooking to make them shelf-stable. Foods with a pH below 4.5 may be safely processed at temperatures around 100°C.

(i) Identify TWO bacteria, apart from *Clostridium botulinum*, that are responsible for food poisoning. **2**

(ii) Explain why it is necessary for home preservers to preserve beetroot in vinegar (acetic acid solution) when pressure-cooking equipment is not available. **4**

Question 29 continues on page 25

Question 29 (continued)

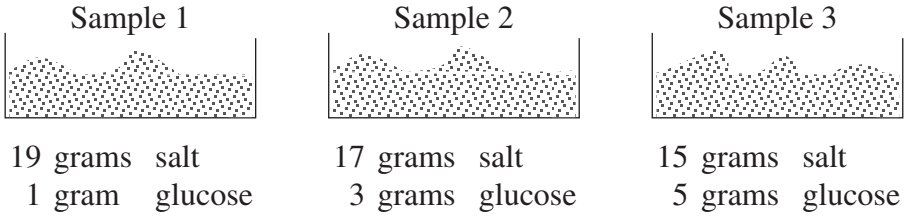
(c) The Australian Food Standards codes are numbers listed on the labels on food products. One ingredient of a generic brand of cooking salt is the anticaking agent 554 (sodium aluminosilicate) while another brand of cooking salt contains 535 (sodium ferrocyanide). **7**

Discuss the use of the Australian Food Standards codes on labels as alternatives to the names of preservatives and additives.

(d) (i) How does salt act as a preservative in food? **1**

(ii) A group of students, Alicia, Daniel, Patrick and Alex, investigated the flow rate of salt and the effect of adding glucose to the salt. **3**

They prepared three samples by mixing different masses of salt and glucose in Petri dishes and allowed them to stand for 48 hours.



They measured the time for each sample to flow through a filter funnel, repeating their experiment to obtain five sets of results for each sample. They recorded their results in the table below.

Trial	*Sample 1* (s)	*Sample 2* (s)	*Sample 3* (s)
1	5.78	6.11	6.42
2	5.75	5.94	6.87
3	5.70	6.24	6.95
4	5.85	5.93	6.37
5	5.81	6.04	6.60

Calculate the average time for each sample, and write a conclusion for their experiment.

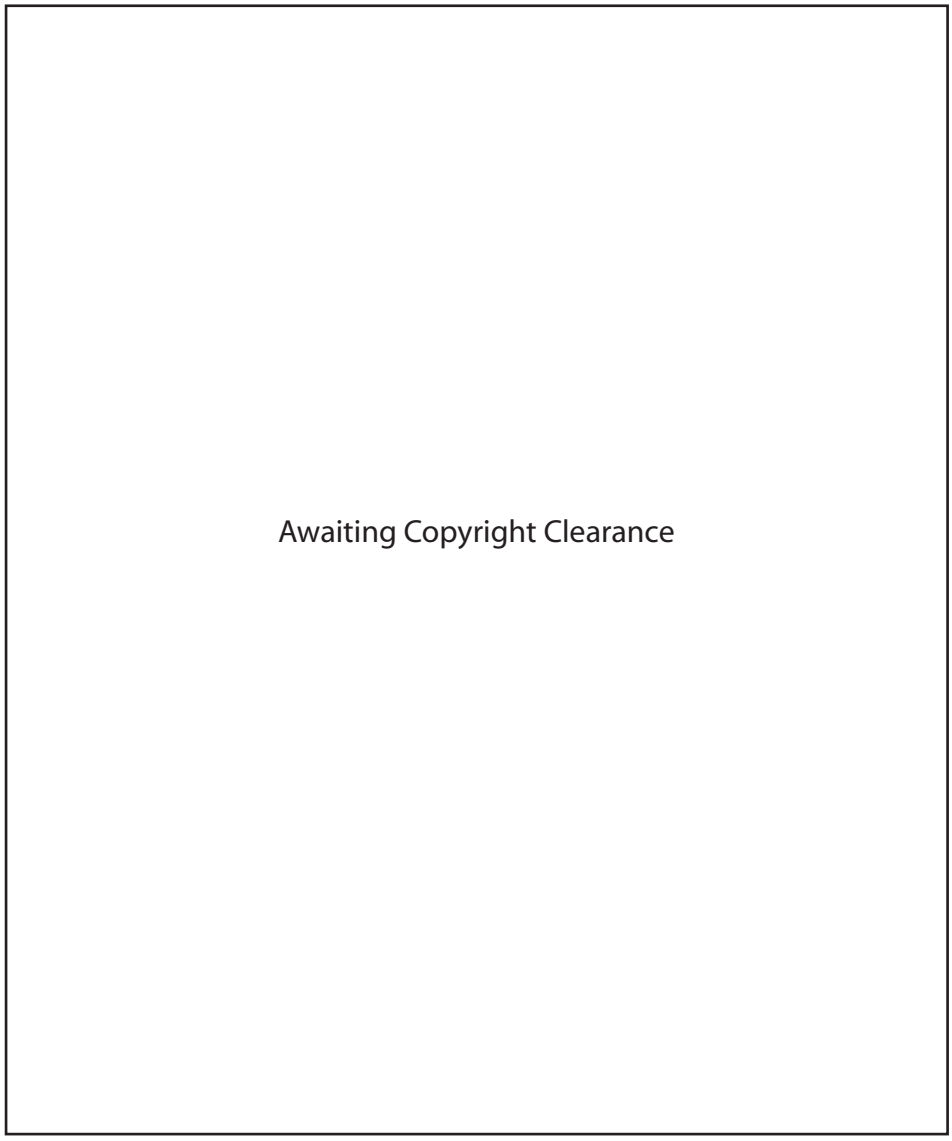
(iii) Justify a method that the students could use to ensure that the investigation in part (ii) was a fair test. **4**

End of Question 29

Marks

Question 30 — Pharmaceuticals (25 marks)

(a) This is a diagram of the human nervous system.



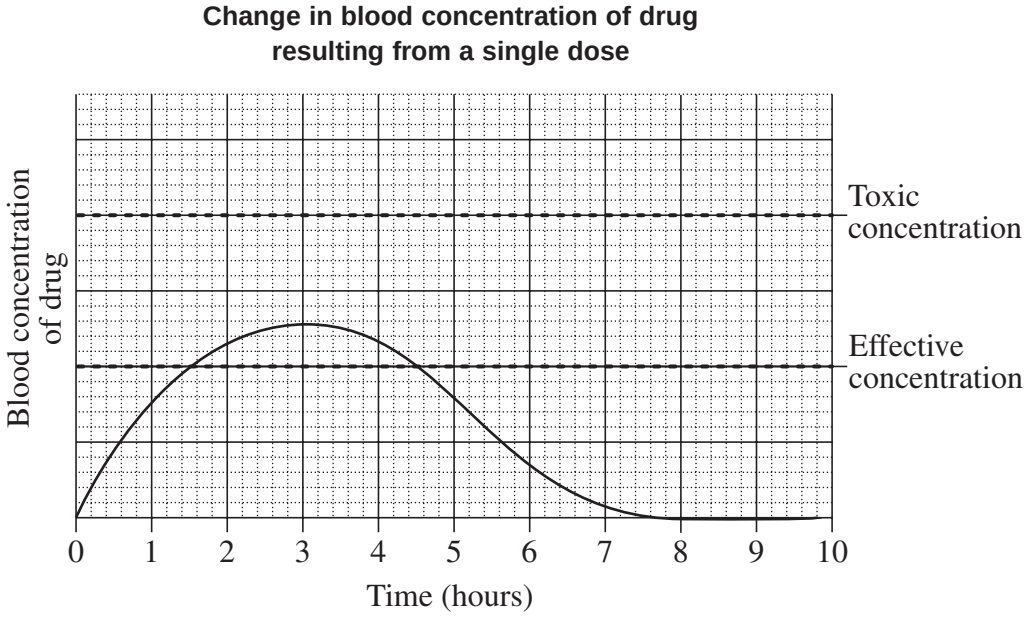
(i) Identify the structures that make up the central nervous system. **1**

(ii) Distinguish between the roles of sensory neurones, motor neurones and interneurones. **3**

Question 30 continues on page 27

Question 30 (continued)

(b) Scott and Jenny gathered information from a pharmaceutical journal article relating to blood concentration changes of a new drug with respect to time. They used this information to construct the graph below.



(i) (1) Based on this graph, how long does it take before the drug becomes effective? **1**

(2) For how long is the drug effective? **1**

(ii) Discuss the use of the circulatory system to transport pharmaceuticals around the body. **4**

(c) Analyse the implications for society of bacteria that are resistant to antibiotics such as penicillin. **7**

(d) In your study of Pharmaceuticals you carried out a first-hand investigation to determine the rate of dissolving of different dispensing forms of analgesics.

(i) Identify the dispensing forms of analgesics studied. **1**

(ii) Draw a flowchart to illustrate the steps in your investigation. **3**

(iii) Write a conclusion from the data you collected, and assess the validity of this conclusion. **4**

End of Question 30

Marks

Question 31 — Disasters (25 marks)

(a) Coping with disasters that affect human populations requires the cooperation and coordination of many help services.

(i) Identify a disaster, and name TWO emergency help services that deal with this disaster. **1**

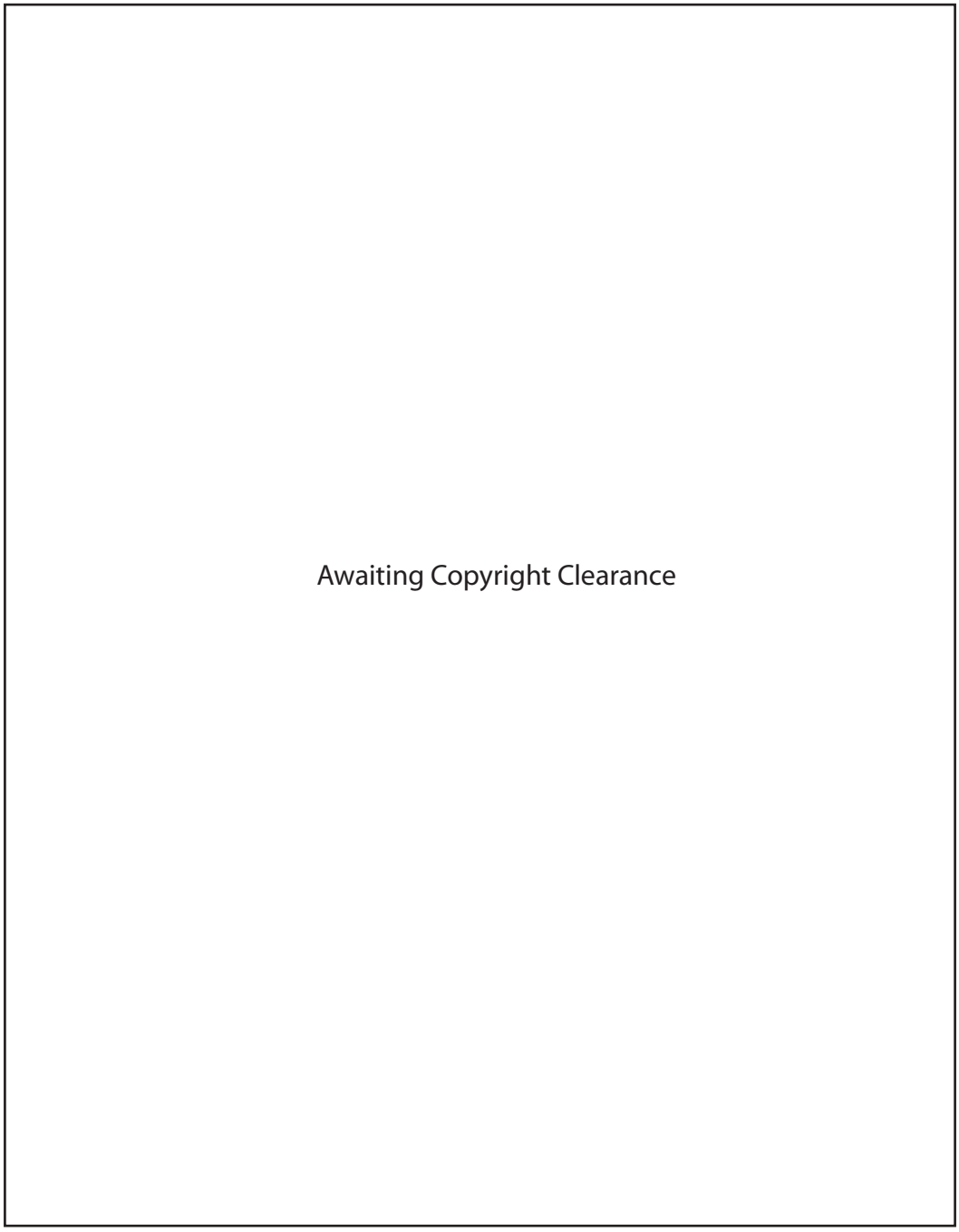
(ii) Identify TWO ways in which each service in part (i) helps to relieve the effects of this disaster on the population. **3**

Question 31 continues on page 29

Marks

Question 31 (continued)

(b) Tropical cyclones are quite common in Australia. They are among the most destructive large-scale storms in the world.



(i) From the poem and newspaper report and the information in the table above, into which category did cyclone Tracy fall? Justify your answer. **2**

(ii) Strong winds are experienced in both tropical cyclones and in bushfires. Explain how these winds are generated in each situation. **4**

Question 31 continues on page 30

Question 31 (continued)

(c) Disasters such as earthquakes and bushfires are difficult to predict. **7**

Discuss this statement and the current technologies that are used to monitor and predict these disasters.

(d) (i) During your study of disasters you performed a first-hand investigation to demonstrate the effect of differences in air pressure.

(1) Describe the method used to demonstrate this effect. **2**

(2) Explain this effect. **2**

(ii) Describe the technological advances that have allowed meteorologists to monitor weather patterns. **4**

End of Question 31

Marks

Question 32 — Space Science (25 marks)

(a) Sir Isaac Newtonís law of gravitation explains both the behaviour of objects on Earth and the movement of the planets. Newton suggested that the Moonís orbit could be explained by a force from Earth pulling on the Moon, which was the same force that causes an apple to fall towards the ground.

(i) State the relationship between mass and the gravitational pull of an object. **1**

(ii) Explain why the Moon remains in orbit around Earth. **3**

(b) The space shuttle was designed as the first reusable space craft.

The space transportation system, commonly referred to as the shuttle, consists of the orbiter, the solid rocket boosters (SRB) and the external propellant tank. The orbiter and SRBs are reusable. The shuttle is 56 metres long and weighs approximately 2 million kilograms.

(i) Explain why large booster rockets are required during the lift-off, but not on re-entry. **2**

(ii) Compare the functions of the solid rocket boosters with the function of the external propellant tank. **4**

Question 32 continues on page 32

Question 32 (continued)

(c) Reduced gravity in space affects the astronaut's ability to carry out normal body functions and meet body needs. Analyse these problems facing an astronaut, indicating how they are solved. **7**

(d)

This is one example of a spin-off from space research. In your course you have investigated a number of spin-offs.

(i) Identify ONE source of relevant information that you used when you gathered information about spin-offs. **1**

(ii) Identify another spin-off from space research, and assess its impact on society. **3**

(iii) Based on the findings of your research, justify whether the space program should be continued or not. **4**

End of paper