

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

2002

**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 13, 17, 21 and 23

Total marks – 100

Section I Pages 2–25

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 27–36

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

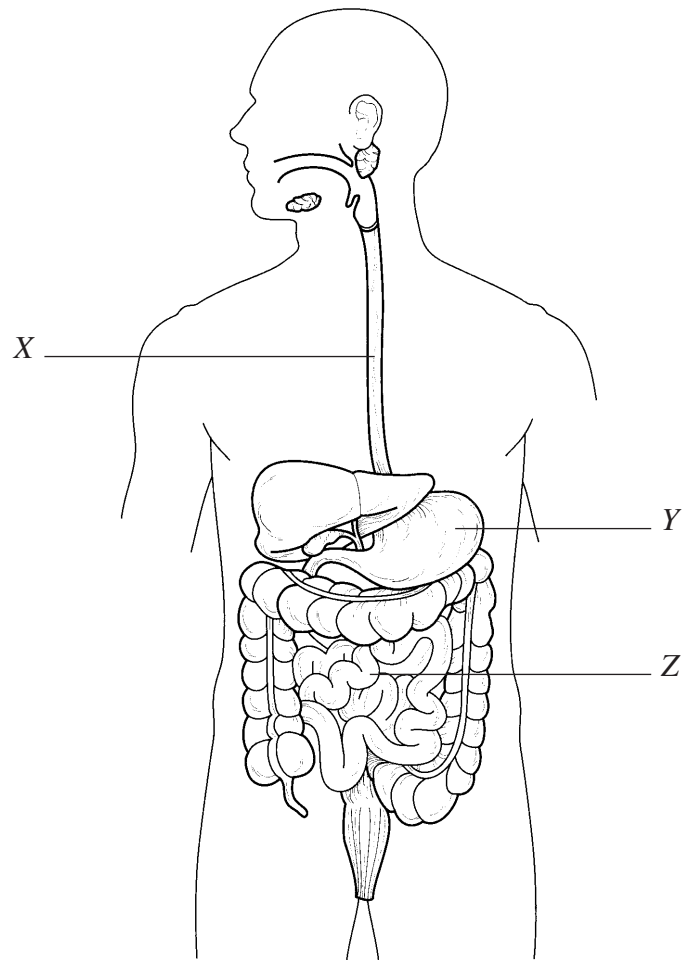
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

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
correct ↙

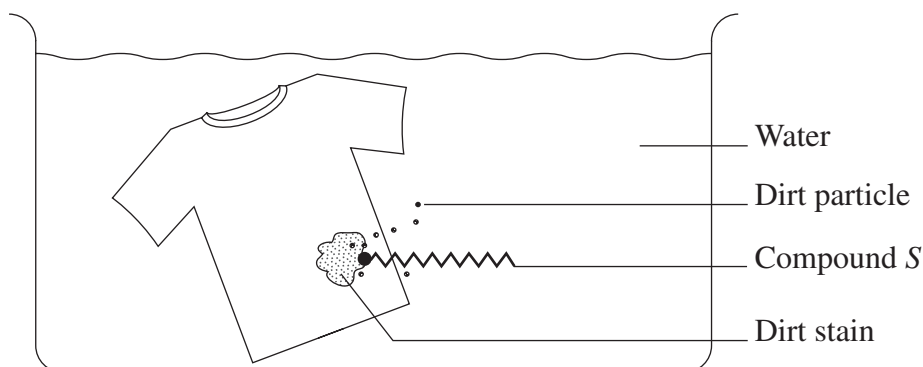
1 The diagram shows the human digestive system.



Which of the following combinations correctly names the labelled parts in the diagram?

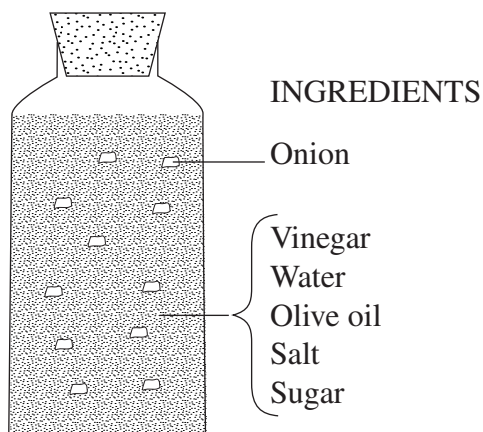
	X	Y	Z
(A)	oesophagus	stomach	small intestine
(B)	large intestine	liver	oesophagus
(C)	oesophagus	stomach	large intestine
(D)	stomach	liver	appendix

- 2 The diagram shows a compound, labelled *S*, and a stained T-shirt in water.



The compound *S* removes dirt particles from the T-shirt. What is compound *S*?

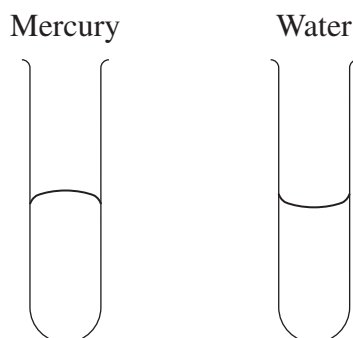
- (A) A salt
 - (B) A surfactant
 - (C) A solvent
 - (D) A solution
- 3 Salad dressing is a mixture. The diagram shows a bottle containing salad dressing after shaking.



Which of the rows in the table shows a correct classification of the ingredients after the bottle is shaken?

	<i>Solute</i>	<i>Solvent</i>	<i>Suspension</i>	<i>Colloid</i>
(A)	Water	Salt	Onion in water	Vinegar in water
(B)	Salt	Vinegar	Onion in water	Olive oil in water
(C)	Onion	Water	Sugar in water	Vinegar in olive oil
(D)	Sugar	Olive oil	Salt in water	Vinegar in water

- 4 The diagram shows two identical test tubes. One contains some mercury and the other contains a similar volume of water.



What conclusion can be reached by observing the shape of each meniscus?

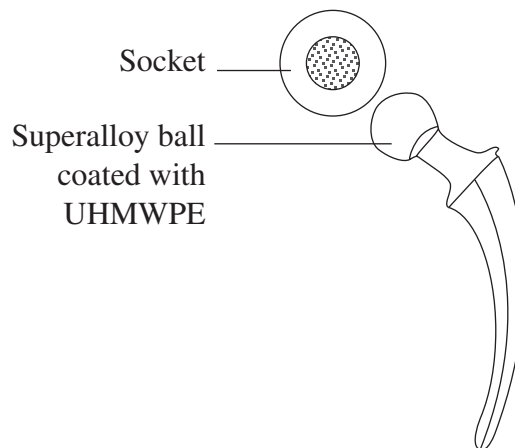
- (A) The surface tension in mercury is greater than the surface tension in water.
(B) The surface tension in water is greater than the surface tension in mercury.
(C) The surface tension in mercury is greater than the forces between mercury particles and the walls of the test tube.
(D) The surface tension in water is greater than the forces between water particles and the walls of the test tube.
- 5 A student investigated the solubility of one type of capsule in solutions of different pH. This type of capsule is intended to be swallowed with water. The results of the student's investigation are recorded in the table.

<i>pH of solution</i>	<i>Time for capsule to dissolve (minutes)</i>
3	60
5	50
7	45
9	3

In what part of the digestive system was the capsule intended to dissolve quickly?

- (A) The oesophagus
(B) The stomach
(C) The small intestine
(D) The large intestine

- 6 Which of the following biomedical devices are used to replace damaged or diseased parts of the skeletal system?
- (A) Pins, screws and plates
 - (B) Cochlear implants
 - (C) Pacemakers
 - (D) Lenses
- 7 What is the medical technique known as angioplasty?
- (A) Insertion of an artificial valve in the heart
 - (B) Lubrication of ball-and-socket joints
 - (C) Replacement of the cartilage of the nose
 - (D) Compression of plaque inside arteries
- 8 The diagram shows an artificial ball-and-socket joint.



Why is a polyethylene (UHMWPE) coating used on the superalloy ball?

- (A) To stop the superalloy from rusting
- (B) To cement the superalloy ball to the bone
- (C) To reduce friction between the ball and the socket
- (D) To increase the attraction between the ball and the socket

- 9 A student compared the concentrations of four gases in air as the air was inhaled, with the concentrations of the same gases when the air was exhaled. The results of the investigation are recorded in the table.

<i>Gas</i>	<i>Concentration in inhaled air (%)</i>	<i>Concentration in exhaled air (%)</i>
<i>W</i>	78	78
<i>X</i>	21	16
<i>Y</i>	0.95	1
<i>Z</i>	0.05	5

Which gas is carbon dioxide?

- (A) *W*
 - (B) *X*
 - (C) *Y*
 - (D) *Z*
- 10 What is the main reason for using cardiopulmonary resuscitation?
- (A) To keep the oxygen and carbon dioxide levels in blood constant.
 - (B) To stimulate the heart to start beating.
 - (C) To maintain oxygen flow to the brain when the heart has stopped beating.
 - (D) To calm people injured in an accident.
- 11 Mr Brown has been experiencing irregular heartbeats. He was referred to a heart specialist who advised him that his normal heart rhythm could be restored.

Of the procedures listed, which would the heart specialist most likely recommend to restore normal heartbeat?

- (A) The fitting of an artificial pacemaker
- (B) A liver transplantation
- (C) Magnetic resonance imaging
- (D) Replacement of heart valves with Teflon implants

- 12** Which type of electromagnetic wave is used to carry messages in optical fibres?
- (A) Radio waves
 (B) Microwaves
 (C) Infra-red rays
 (D) Visible light
- 13** What is one advantage of using microwaves instead of radio waves in communication systems?
- (A) Microwaves travel faster.
 (B) Microwaves require more energy to be generated.
 (C) Signal booster or repeater stations are not required.
 (D) Smaller antennae can be used for signal reception.
- 14** The table gives some information about four satellites orbiting Earth.

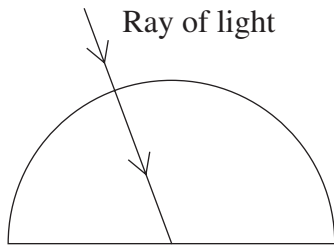
<i>Satellite</i>	<i>Mass (kg)</i>	<i>Altitude (km)</i>	<i>Period of revolution</i>
<i>W</i>	2.2×10^3	833	1 hour 41 minutes
<i>X</i>	2.1×10^3	35 786	23 hours 56 minutes
<i>Y</i>	1.1×10^3	450	1 hour 30 minutes
<i>Z</i>	7.4×10^{22}	384 467	655 hours 44 minutes

Which of the following is a geostationary satellite?

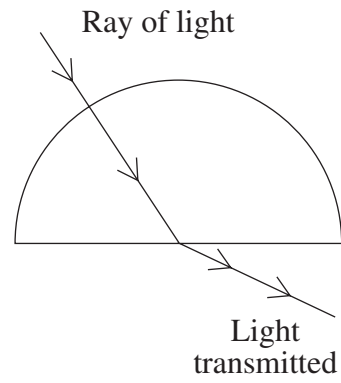
- (A) *W*
 (B) *X*
 (C) *Y*
 (D) *Z*

15 Which of the following diagrams illustrates the principle that allows optical fibres to carry information around curves?

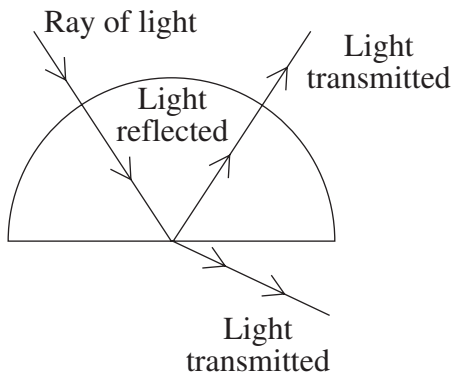
(A)



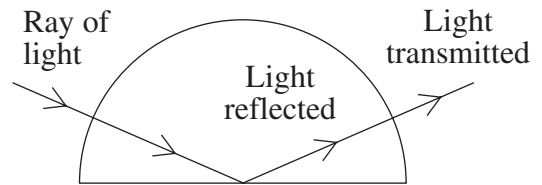
(B)



(C)



(D)



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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.

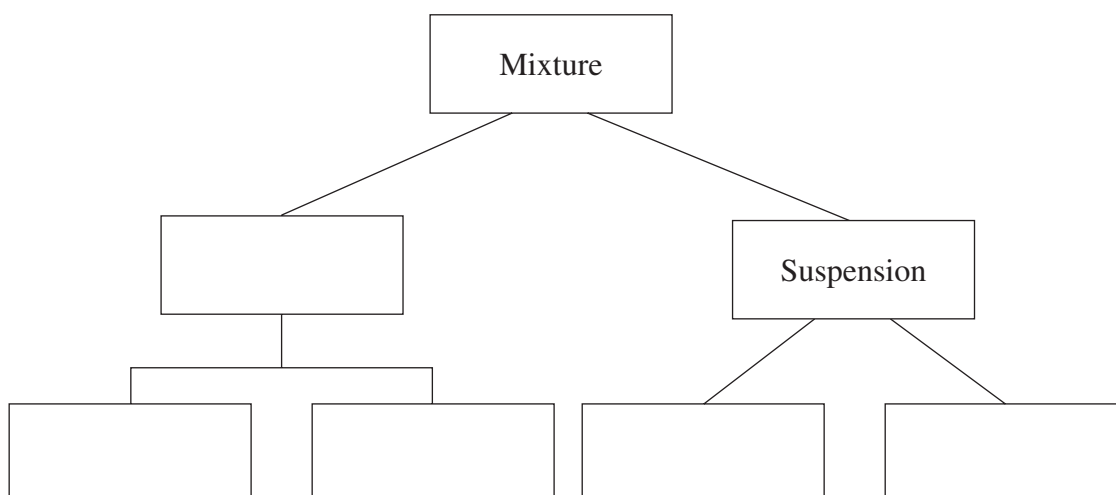
Marks

Question 16 (3 marks)

Complete the diagram to show how each of the following terms is linked.

3

Mixture, solution, solvent, suspension, emulsion, colloid, solute



Question 17 (3 marks)

The label on a container of surface cleaner has the following information.

Ingredients:
Solvent to dissolve grease; cleaning and foaming agents (anionic and non-ionic surfactants); detergent aid; preservatives; colour and perfume. Contains no phosphorus.

Caution:
Poisonous. Keep out of reach of children. If product contacts eyes, rinse thoroughly with water. Ensure adequate ventilation in confined space.

- (a) Give ONE reason why this product should be kept out of the reach of children. **1**

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- (b) Outline the procedures you would follow if a child swallowed this surface cleaner. **2**

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Question 18 (4 marks)

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Colin noticed that the skin around his teeth sometimes became red and sore. He thought this could be caused by the pH of the toothpaste he used. Marilyn designed an investigation to test Colin’s idea.

They measured:

- the pH levels in their mouths;
- the pH levels of different brands of toothpaste;
- the area of skin irritation caused when a 2 cm length of each of the different toothpastes was placed directly on the skin on the inner side of the forearm.

The pH level of Marilyn’s mouth was 6.5 and the pH level of Colin’s mouth was 7.5.

Toothpaste brand	<i>Brand A</i>	<i>Brand B</i>	<i>Brand C</i>
pH level	6.5	7.0	7.5
Area of skin irritation on Marilyn	2 cm × 0.5 cm	2 cm × 1 cm	3 cm × 2 cm
Area of skin irritation on Colin	3 cm × 2 cm	2 cm × 1 cm	2 cm × 0.5 cm

From these results, Colin concluded that the pH of the toothpaste must be causing the redness. Marilyn thought that there may be something else in the toothpaste that was making the skin red.

Discuss the validity of Colin’s conclusion. In your answer, you should refer to the experimental design and the results.

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Question 19 (6 marks)

Design an investigation to compare the solubility of oil in liquid soaps and shampoos.

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Your answer should include:

- a description of the method;
- identification of the dependent variable and the independent variable;
- an explanation of how you could ensure the reliability of the result.

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Centre Number

Section I – Part B (continued)

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Student Number

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Question 20 (5 marks)

The skin is an organ that protects the body against disease.

- (a) Identify ONE other role of the skin. **1**

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- (b) The manufacturer of a skin cream claims that it will treat acne. A student wishes to test this claim.

- (i) Identify a risk associated with trialling skin creams on humans. **1**

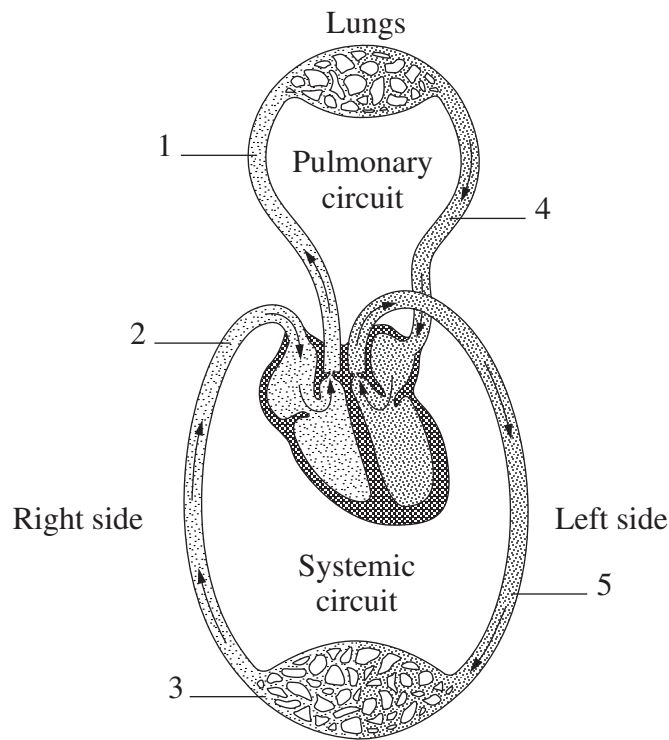
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- (ii) Describe the consequences associated with changing the natural pH of the skin. **3**

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Question 21 (3 marks)

The diagram summarises the circulation of blood around the body to provide oxygen and remove carbon dioxide.



Artificial lungs are necessary to maintain life during some operations. Which numbers on the diagram (1, 2, 3, 4 or 5) show blood with the same amount of oxygen as the blood returning to the body from an artificial lung? Justify your answer.

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Question 22 (7 marks)

Discuss how minimally invasive surgery and non-invasive diagnostic techniques have reduced risks to patients.

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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 23 (5 marks)

(a) Describe the structure and function of heart valves.

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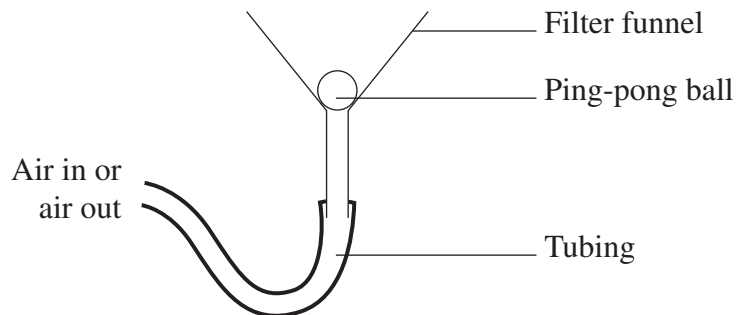
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(b) The following set-up could be used to model heart valves.



Discuss the advantages and disadvantages of this model in demonstrating the function of heart valves.

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Question 24 (4 marks)

Draw up a time line which shows the historical development of society's use of pacemakers, showing the key technological advances that have made their development possible. You do not need to provide exact dates. **4**

Question 25 (4 marks)

(a) Identify ONE communication technology that transforms one type of energy into electrical energy when it is in use. **1**

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(b) Describe the properties of electromagnetic waves and relate these properties to their use in communication systems. **3**

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Centre Number

Section I – Part B (continued)

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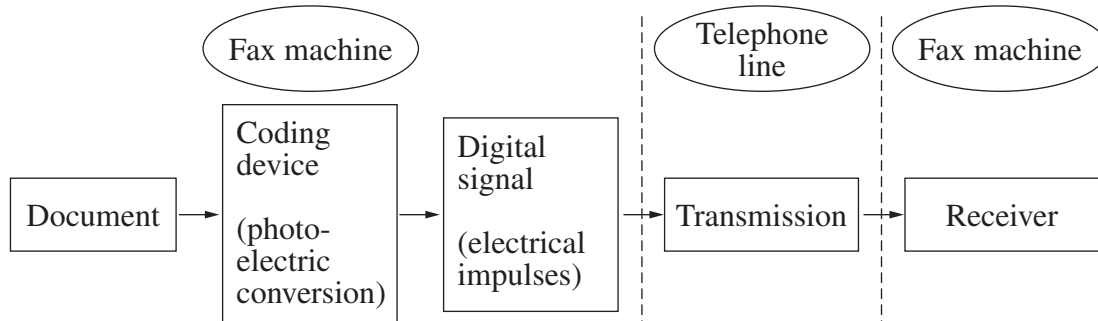
Student Number

Question 26 (8 marks)

Please turn over

Question 26 (8 marks)

The diagram shows the basic processes involved in a facsimile transmission device (fax machine).



(a) Construct a simple diagram showing the steps involved in the process of producing the final copy in the fax receiver. **3**

(b) Explain how the images on the document are changed into a signal that can be transmitted and later decoded. **5**

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Question 27 (8 marks)

During your course you performed an investigation to observe ways in which waves can be modified to carry information.

8

Write a scientific report on this investigation. Your report should include an aim, a method, observations and conclusions.

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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	28–29
Question 29 Preservatives and Additives	30–31
Question 30 Pharmaceuticals	32–33
Question 31 Disasters	34–35
Question 32 Space Science	36

Question 28 — Polymers (25 marks)

(a) Shopping bags and other plastic objects are not decomposed by micro-organisms.

(i) Define the term *biodegradability*. **1**

(ii) Describe some environmental impacts of plastic bags that have been washed through stormwater drains into a waterway. **3**

(b)

A farmer gazes at rows of tall, leafy corn plants as far as the eye can see. The farmer smiles to himself, because he knows something about his crop that few people realise. Not only are kernels of corn growing in the ears, but granules of plastic are sprouting in the stalks and leaves.

The idea of growing plastic corn kernels may be achieved in the future and may replace the manufacturing of plastic in petrochemical factories. These factories consume about 270 million tons of oil and gas every year worldwide. Fossil fuels provide both the power and the raw materials that transform crude oil into common plastics.

It is difficult to imagine everyday life without plastics, but the sustainability of their production has increasingly been called into question.

(i) What are the major sources of raw materials for the manufacture of plastics? **1**

President Clinton believed that replacing fossil fuel sources of plastic with ones derived from plant materials would be beneficial.

(ii) Refer to the passage and your study of this option to evaluate President Clinton's belief. **5**

(c) Plastics can be classified as either thermosetting or thermoplastic. **7**

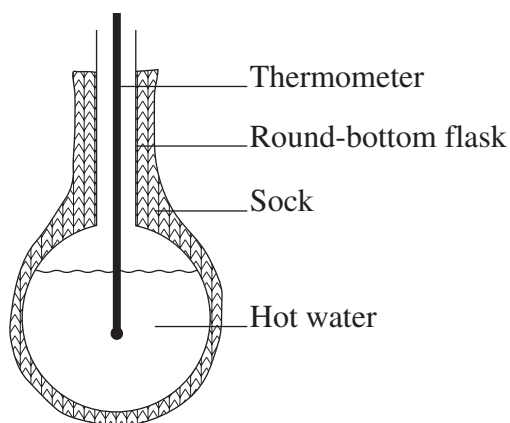
Discuss how these properties of plastics have resulted in a variety of uses. In your answer, explain the meaning of the terms 'thermosetting' and 'thermoplastic'.

Question 28 continues on page 29

Question 28 (continued)

- (d) (i) Name ONE natural polymer used to make textiles. 1
- (ii) One property of natural polymers is thermal insulation. Identify TWO other properties of the natural polymer you named in part (d) (i) that make this polymer useful in the textile industry. 2
- (iii) A student designed an investigation to identify which of three types of sock material was best at preventing heat loss. 5

He covered a round-bottom flask containing hot water with a sock and recorded the temperature of the water at one minute intervals for 10 minutes. His apparatus is shown in the diagram. He then repeated the experiment using socks made of the other materials.



Identify the variables that must be controlled to make this a fair test. Give reasons for your answer.

End of Question 28

Question 29 — Preservatives and Additives (25 marks)

- (a) (i) Identify ONE substance that can be used as a natural food dye. **1**
- (ii) Describe the effects of adding food dyes to food. **3**
- (b) The Australia New Zealand Food Authority (ANZFA) has published the Food Standards Code.
- In this Code, the term ‘preservatives’ includes:
- benzoic acid and its salts
 - dimethyl dicarbonate
 - methylparaben
 - sulfur dioxide
 - nisin
 - sorbic acid and its salts
 - propionic acid and its salts.
- (i) Identify a bacteriocin from the list above. **1**
- (ii) Assess the need for control and labelling of additives and preservatives in food and drink products. **5**
- (c) Discuss the historical development of our scientific understandings of the causes of food spoilage. In your answer, you should relate these understandings to improved methods of food preservation and the impact of these methods on society. **7**

Question 29 continues on page 31

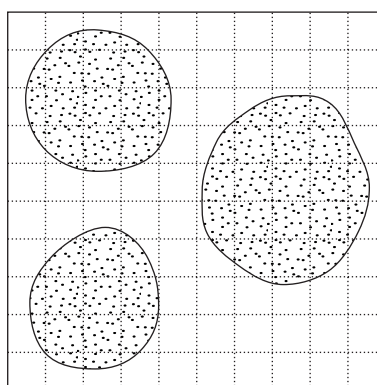
Question 29 (continued)

- (d) A student carried out an investigation to determine the minimum temperature to which soup should be heated to ensure that all micro-organisms are destroyed. In her investigation she heated soups to different temperatures, extracted samples of the soups and grew the samples in 10 cm agar square dishes.

After three days she estimated the percentage cover of micro-organisms on the agar by using a grid. Her results are shown in the table.

<i>Temperature to which the soup was heated (°C)</i>	<i>Percentage of the agar plate covered by micro-organisms</i>
30	20
40	40
50	60
60	80
70	0
80	0

- (i) Using the information in the table, determine the minimum safe temperature to which soup should be heated to destroy the micro-organisms. **1**
- (ii) The diagram shows colonies of micro-organisms that were grown on agar in a 10 cm square dish from a sample of her soup. **3**



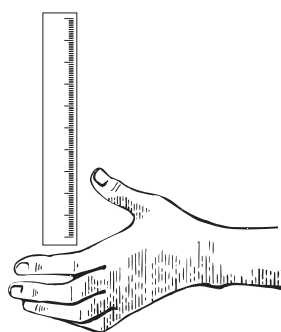
Determine the percentage of the agar covered in micro-organisms and the temperature to which the soup was heated. Show your working.

- (iii) How should the student minimise any potential risks involved in carrying out this investigation? **4**

End of Question 29

Question 30 — Pharmaceuticals (25 marks)

- (a) (i) Identify the main parts of the central nervous system. **1**
- (ii) Draw a flowchart to show what happens to aspirin from ingestion to when it provides relief of pain. **3**
- (b) Two students, one boy (Stephen) and one girl (Annette), carried out an investigation to see if boys and girls have the same reaction time. The experimental set-up is shown in the diagram. Each student had to catch the ruler after the other student dropped it without warning. They measured the distance the ruler fell before it was caught. Each student did this five times.



The results are shown in the table.

<i>Trial number</i>	<i>Distance ruler fell (cm)</i>	
	<i>Stephen</i>	<i>Annette</i>
1	24	23
2	35	23
3	26	24
4	40	23
5	45	20

- (i) State ONE reason why the results of this investigation may not be valid. **1**
- (ii) Analyse the role played by the students' central and peripheral nervous systems when catching the ruler. **5**
- (c) Explain the advantages and disadvantages of inflammation to the body. **7**

Question 30 continues on page 33

Question 30 (continued)

(d) During your study of Pharmaceuticals you carried out an investigation to relate the growth rate of bacteria to temperature.

- (i) Identify ONE variable that you needed to keep the same for all samples during the investigation. **1**
- (ii) The table below shows the results obtained in one such investigation, using six samples grown at different temperatures. **3**

		<i>Bacteria population (colonies)</i>	
<i>Sample</i>	<i>Temperature (°C)</i>	<i>Day 1</i>	<i>Day 5</i>
1	25	100	200
2	35	120	300
3	45	300	900
4	55	150	900
5	65	100	0
6	75	100	0

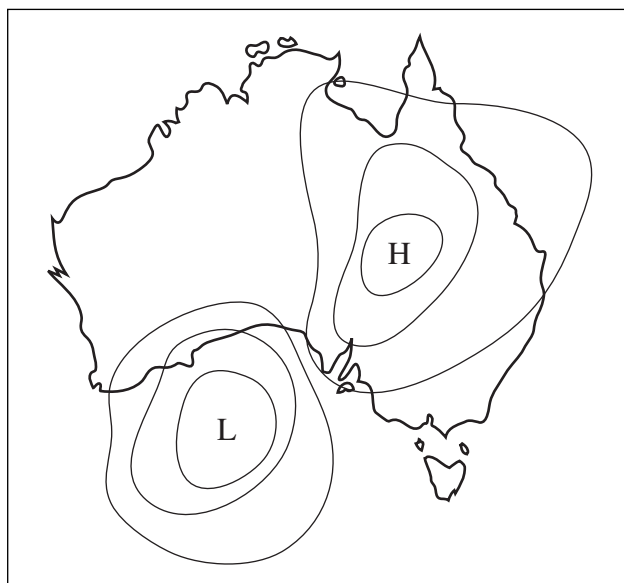
Which temperature was best for growing these bacteria? Justify your answer.

- (iii) Identify a risk in growing bacteria, and describe the steps that were taken to reduce this risk. **4**

End of Question 30

Question 31 — Disasters (25 marks)

(a)



- (i) Name the lines around the letters 'L' and 'H' on the above weather map. **1**
 - (ii) Describe the movement of air currents from one air pressure system to another. **3**
- (b) An earthquake in Turkey in 1999 measuring 7.4 on the Richter scale caused the death of nearly 40 000 people and extensive property damage. The earthquake in Newcastle in 1989 measured 5.6 on the Richter scale and caused 13 deaths and far less damage to property.
- (i) Account for the different amounts of damage caused by the two earthquakes. **3**
 - (ii) Identify ONE emergency service needed in an earthquake and outline its role and the problems it may face in performing that role. **3**

Question 31 continues on page 35

Question 31 (continued)

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|-----|---|----------|
| (c) | Discuss the technological developments that have allowed early warnings for ONE type of disaster. | 7 |
| (d) | In your study of this option, you have undertaken research into the factors that promote the spread of bushfires. | |
| | (i) Identify ONE factor found in your investigation that promoted the occurrence or spread of a bushfire. | 1 |
| | (ii) Outline the steps you would take to assist survival if you were caught in a bushfire. | 3 |
| | (iii) Outline an investigation you have performed to compare the flammability of dry and fresh leaves. Include the aim, the method used and the findings of your investigation. | 4 |

End of Question 31

Question 32 — Space Science (25 marks)

- (a) (i) Identify ONE example of a human circadian rhythm. **1**
- (ii) Describe how astronauts living in a space station could maintain normal circadian rhythms. **3**

(b)

In many areas, we use products and services developed through space research. These include:

- television broadcasting
- thermal blankets
- weather forecasting
- miniaturisation of computer systems, calculators and mobile phones
- protective clothing
- robotics
- solar power
- composite materials from carbon fibres
- foodstuffs
- packaging
- ceramics.

The list is long and shows the positive contribution of space research to our quality of life.

- (i) Choose ONE of the products and services listed and compare its original use to its current use. **2**
- (ii) Assess the impact that spin-offs from space research have had on society. **4**
- (c) Two locations have been suggested for the building of a telescope. One location is high on an isolated mountain; the other is on a coastal plain near a large city. **7**
- Where should the telescope be built? Justify your answer.
- (d) The astronauts who lived on the MIR space station for more than a year lost up to two-thirds of their muscle mass during their stay in space.
- (i) Describe the role of gravity in the maintenance of muscle tone. **2**
- (ii) From your investigations into the maintenance of muscles in space, design a program of exercises for the major muscle groups of the body that could be performed in the confines of a spacecraft. **6**

End of paper

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