



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

2003

**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 2–20

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 21–29

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 Some dishwashing liquids are labelled 'biodegradable'.

Why is being biodegradable an important property of dishwashing liquids?

- (A) It means that they provide no nutrients for food chains in waterways.
- (B) It makes them more effective in cleaning up insoluble wastes such as fats and oils.
- (C) It makes them less harmful to the people using them than non-biodegradable detergents.
- (D) It allows them to be broken down by bacteria to reduce long-term damage to the environment.

2 Which of the following is an important role of human skin?

- (A) The pH of the skin neutralises the acids in soaps.
- (B) The skin assists the body to control its temperature.
- (C) The skin burns when exposed to the sun for lengthy periods.
- (D) The skin acts as an entry point for disease-causing organisms.

3 The label from an aftershave lotion is shown below.



Why is alcohol, rather than water, included as one of the ingredients of this cosmetic product?

- (A) Some of the other ingredients will dissolve better in alcohol than in water.
- (B) The consumers will feel better after using a product containing alcohol.
- (C) The cosmetic is less flammable if alcohol is used instead of water.
- (D) The alcohol will not evaporate as quickly as water.

- 4 Which row in the table identifies the pH in the stomach and the small intestine?

	<i>Stomach</i>	<i>Small intestine</i>
(A)	2	3
(B)	2	8
(C)	8	9
(D)	9	2

- 5 A team of students carried out an investigation to compare the pH of a range of cosmetic products designed for use on the skin. A one-gram sample of each cosmetic product was placed in separate test tubes, and then diluted with water. Universal indicator solution was added to each test tube to measure the pH of each sample.

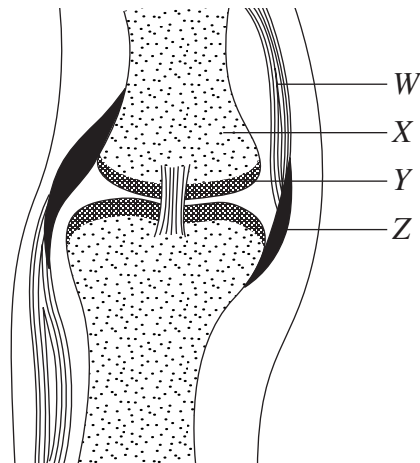
What should the students have done to ensure that the investigation was a fair test?

- (A) They should have tested cosmetic products that were packaged in the same size and type of container.
- (B) They should have diluted each cosmetic product in each test tube using the same volume of water.
- (C) They should have used the same size test tube to test each cosmetic product.
- (D) They should have used cosmetic products with the same use-by date.
- 6 Which of the following operations requires the use of an artificial lung?
- (A) A hip replacement
- (B) Laser surgery on the eye
- (C) Keyhole surgery for gallstones
- (D) A heart transplant from a suitable donor
- 7 Non-invasive medical techniques are often used because they reduce risk to the patient.

Which of the following is an example of such a technique?

- (A) Thermography
- (B) Silicone implant
- (C) Blood transfusion
- (D) Pacemaker implant

- 8 The diagram represents a synovial joint.



Which row in the table correctly matches the labels *W*, *X*, *Y* and *Z* with the names of the parts of the joint?

	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
(A)	Muscle	Bone	Tendon	Cartilage
(B)	Muscle	Bone	Cartilage	Tendon
(C)	Tendon	Bone	Cartilage	Muscle
(D)	Tendon	Cartilage	Bone	Muscle

- 9 A person was found to have severe damage to structures in the cochlea.

Why could this person benefit from a cochlear implant?

- (A) It will restore normal hearing.
- (B) It can be fitted without surgery.
- (C) It can convert sound to electrical impulses.
- (D) It is a completely external hearing device.

- 10 Polyethylene (UHMWPE) is a replacement for damaged cartilage that surrounds the ball-and-socket joint.

Which of the following properties makes polyethylene a suitable replacement?

- (A) Low friction and high durability
- (B) Biodegradability in surrounding tissue
- (C) Flexibility and high solubility in water
- (D) Low molecular weight that allows it to fit into very small places

- 11 Narrowing of the opening of the aortic valve is a common heart defect.

Which of the following problems may result from this defect?

- (A) The blood supply to body tissues may increase.
- (B) The heartbeat may slow due to the narrowness of the valve.
- (C) Heart failure may result as the heart needs to work harder.
- (D) The circulation rate may increase, making the heart beat faster.

- 12 The following paragraph describes how a fax machine works.

The paper is fed into the machine, where a photoelectric cell detects small spots on the paper. The photoelectric cell moves rapidly from left to right across the page, sending a series of pulses of different frequencies down the phone line. The fax machine sends a pulse of 1300 hertz if the spot is black and a pulse of 800 hertz if the spot is white.

A fax message included six pulses in sequence. These pulses had frequencies of 800, 1300, 800, 800, 1300 and 1300 hertz.

Which of the following sequences of dots is represented by this message?

- (A) ○ ● ○ ○ ● ●
- (B) ● ● ○ ○ ● ○
- (C) ○ ● ○ ○ ○ ●
- (D) ● ○ ● ● ○ ○

- 13 Which of the following identifies information systems that all rely on the use of an electronic device to decode messages?
- (A) AM radio, textbook, traffic light
 - (B) Compact disc, DVD, stop sign
 - (C) Email, land-connected telephone, mobile phone
 - (D) Newspaper, radio, television

- 14 'Flash Phone' is a new generation mobile phone with an inbuilt digital camera.

How does the 'Flash Phone' transmit a picture taken with the inbuilt camera?

- (A) The picture is transmitted uncoded.
- (B) The picture is transmitted as an electrical current.
- (C) The picture is reduced to a number of lines and transmitted.
- (D) The picture is transmitted as a series of zeros and ones.

- 15 The table lists properties of some types of electromagnetic radiation.

<i>Type of wave</i>	<i>Typical frequency (Hz)</i>	<i>Typical wavelength (m)</i>	<i>Speed of transmission (m s^{-1})</i>
AM radio	10^6	10^2	3×10^8
FM radio	10^8	1	3×10^8
Microwaves	10^{10}	10^{-2}	3×10^8
Visible light	10^{14}	10^{-6}	3×10^8

What can be concluded from the data in the table?

- (A) Visible light has a longer wavelength than FM radio.
- (B) AM radio and microwaves have the same typical wavelength.
- (C) The frequency of AM radio is 10^8 times lower than that of visible light.
- (D) The speed of transmission of AM radio waves is different from that of microwaves.

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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)

Describe how subdermal implants release their medication into the body.

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Please turn over

Question 17 (5 marks)

A manufacturer claims that its handwash gel, Brand X, removes potentially harmful bacteria and leaves hands soft and smooth.

The claim was tested by students. Three groups, each consisting of the same number of students, performed the same sequence of tasks (housework, gardening, grooming dog/cat, and reading newspaper) as listed in the table below. Each group took the same time to perform the same sequence of tasks. Each task brought each student into contact with bacteria.

Group 1 washed their hands with gel Brand X after each task.

Group 2 washed their hands with water only, after each task.

Group 3 did not wash their hands at all.

Bacteria remaining on the hands of all students were sampled following each task, and grown on agar plates. The number of bacterial colonies grown on each agar plate was counted.

GROUP	Number of bacterial colonies present			
	TASK			
	<i>Housework</i>	<i>Gardening</i>	<i>Grooming cat/dog</i>	<i>Reading newspaper</i>
Group 1 washed with gel Brand X	1	2	3	1
Group 2 washed with water	6	9	12	3
Group 3 did NOT wash	15	18	24	29

- (a) Identify the manufacturer’s claim about gel Brand X that was under investigation. 1

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- (b) Outline ONE safety issue relating to this investigation. 1

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Question 17 continues on page 11

Question 17 (continued)

- (c) Discuss whether these results support the manufacturer’s claims. 3

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Question 18 (6 marks)

Different kitchen cleaning agents were tested by two students, Graham and Philippa. Graham had suggested that the Yippy Yi Yo brand (an emulsion) was a better cleaning agent than the Kildembugs brand (a suspension) because an emulsion is easier to use than a suspension. Philippa did not agree.

- (a) Define the term *suspension*. 1

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- (b) Outline TWO ways in which an emulsion differs from a suspension. 2

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- (c) Describe how you would test which of the two cleaning agents is easier to use. 3

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Question 19 (7 marks)

The following are the findings of two independent research studies.

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- 1 Research on an Australian naval vessel found that the transmission of a respiratory virus, such as the cold or flu virus, was significantly reduced if the members of the crew washed their hands frequently.
- 2 Different research showed that frequent washing of the hands resulted in the oils on the hands being removed, exposing the normal microflora on the skin. This in turn provided a source of contamination when handling food.

Evaluate the findings of these studies in relation to the role of microflora on the skin.

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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 20 (3 marks)

- (a) Why is magnetic resonance imaging (MRI) considered a non-invasive medical diagnostic technique? 1

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- (b) (i) What is meant by *keyhole surgery*? 1

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- (ii) What is an advantage of this technique compared with conventional ‘open’ surgical techniques? 1

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Question 21 (4 marks)

Compare and contrast properties of silicone and polyethylene that make them suitable as polymers in artificial joints. 4

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Question 22 (3 marks)

Ronald Huckstep was Foundation Professor of Traumatic and Orthopaedic Surgery at the University of NSW. His ingenuity led him to develop new methods of repairing bone fractures, pioneering the use of titanium alloy for implants in 1972, and inventing the first locking cementless hip in 1979.

In the light of this work, discuss the differences between using cemented and uncemented implants. **3**

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Question 23 (4 marks)

(a) (i) Biomedical devices that can replace body parts include artificial hips or cochlear implants. Identify another biomedical device. **1**

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(ii) Outline a circumstance in which this device would be used. **1**

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(b) Recommend TWO relevant sources of information you could access to trace the historical development of a biomedical device. **2**

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Question 24 (6 marks)

You performed a first-hand investigation to examine the flexible nature of bones.

- (a) Outline a safety precaution relevant to this investigation. **1**

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- (b) Complete the list of equipment you used. **2**

1. Chicken bone
2.
3.

- (c) Describe your results, and relate your findings to the role of the skeleton. **3**

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Centre Number

Section I – Part B (continued)

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Student Number

Marks

Question 25 (8 marks)

(a) Use a labelled diagram to illustrate the principle of total internal reflection. **2**

(b) Explain how the property of total internal reflection benefits the transmission of information through optic fibres. **2**

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Question 25 continues on page 18

Question 25 (continued)

- (c) Construct a table contrasting copper cables and fibre optic cables for their carrying capacity and security. **4**

End of Question 25

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Centre Number

Section I – Part B (continued)

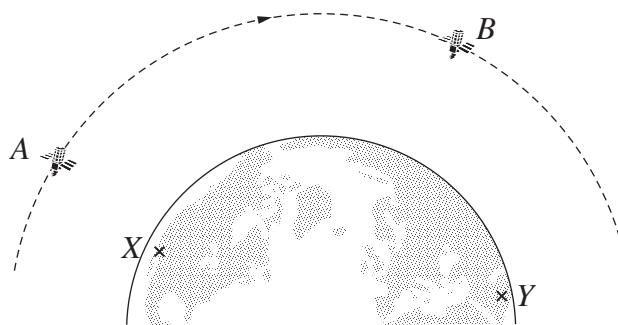
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Student Number

Marks

Question 26 (5 marks)

Two geostationary satellites, labelled *A* and *B* on the diagram, are travelling at the same speed and at the same height above Earth’s surface.



- (a) Define what *geostationary* means in the term *geostationary satellite*. **1**

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- (b) Explain why it is important for a communication satellite to have a geostationary orbit. **2**

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- (c) Explain how a person at location *X* can view a live telecast of an event at location *Y*. **2**

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Question 27 (6 marks)

Different types of waves in the electromagnetic spectrum are used for communication systems. For example, AM and FM radio both use radio waves.

(a) (i) Identify a communication system that uses microwaves. **1**
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(ii) Identify another communication system that uses radio waves. **1**
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(b) (i) Use labelled diagrams to contrast AM (amplitude modulated) and FM (frequency modulated) radio waves. **2**

(ii) Explain ONE disadvantage of using microwaves in a communication system. **2**
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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	22–23
Question 29 Preservatives and Additives	24
Question 30 Pharmaceuticals	25–26
Question 31 Disasters	27
Question 32 Space Science	28–29

Question 28 — Polymers (25 marks)

- (a) (i) During your study of Polymers, you examined plastics. 1
Define the term *plastics*.
- (ii) Describe the effect of heating and then cooling two picnic plates; one is a thermoset plastic and the other is thermoplastic. 3
- (b) The table lists commonly used plastics and their recycling codes.

Commonly used plastics		
Plastic name, abbreviation and the plastic identification code	Characteristics	Examples
Polyethylene terephthalate (PET) 	Clear, tough, solvent resistant, often used as fibre	Carbonated softdrink bottles, pillow and sleeping bag filling, textile fibres, detergent bottles
High Density Polyethylene (HDPE) 	Hard to semi-flexible, waxy surface, opaque, melts at 135°C	Crinkly shopping bags, freezer bags, milk bottles, bleach bottles, buckets, rigid agricultural pipe, milk crates
Unplasticised Polyvinyl Chloride (UPVC) Vinyl 	Hard, rigid, can be clear, can be solvent welded	Electrical conduit, plumbing pipes and fittings, blister packs, clear cordial and fruit juice bottles
Plasticised Polyvinyl Chloride (PPVC) Vinyl 	Flexible, clear, elastic, can be solvent welded	Garden hose, shoe soles, cable sheathing, blood bags and tubing, watch straps
Low Density Polyethylene (LDPE) 	Soft, flexible, waxy surface, translucent, melts at 80°C, scratches easily	Garbage bags, squeeze bottles, black irrigation tube, black mulch film, garbage bins, food bags
Polypropylene (PP) 	Hard but still flexible, waxy surface, melts at 145°C, translucent, withstands solvents. Very versatile materials with many applications	Potato crisp bags, drinking straws, microwave ware, plastic kettles, plastic garden settings, baby baths, plastic-hinged lunch boxes
Polystyrene (PS) 	Clear, glassy, rigid, brittle, opaque, semi-tough, melts at 95°C. Affected by fats and solvents	Plastic cutlery, imitation 'crystal' glassware, low-cost brittle toys, appliances, medical ware
Expanded Polystyrene (EPS) 	Foamed, lightweight, energy absorbing, heat insulating	Protective packaging for fragile items, insulation, produce boxes
Other 	Includes all other resins and multi materials (eg laminates). Examples are polyamide, acrylonitrile butadiene styrene (ABS), acrylic, nylon, polyurethane (PU) and phenolics.	

Reproduced with the permission of the Plastics and Chemicals Industries Association.

- (i) Many local councils collect plastics numbered 1 and 2 for recycling. Name ONE plastic item that is commonly used in the home and can be collected by the council for recycling. 1
- (ii) Using examples from the table, assess the impact of plastics in terrestrial and aquatic environments. 5

Question 28 continues on page 23

Question 28 (continued)

- (c) Analyse the possible implications of a reduction in supply of the raw materials required to produce synthetic polymers. In your answer, identify the sources from which the chemicals are extracted to manufacture these polymers. **7**
- (d) (i) Name and describe ONE property of a natural polymer. **2**
- (ii) In your study of Polymers, you carried out a first-hand investigation to compare the properties of natural polymers such as hair, wool, silk and cotton. Write a report on your investigation into ONE property of natural polymers. Your report must include the aim, method, results and conclusion. **6**

End of Question 28

Question 29 — Preservatives and Additives (25 marks)

- (a) (i) Identify ONE bacterial microbe that causes spoilage in food. **1**
- (ii) Describe how the use of ultra-high temperature (UHT) as a preservative measure has improved the quality of food available for society. **3**
- (b) (i) Identify ONE way in which bacteriocins can be used to preserve food. **1**
- (ii) The diagrams show labels found on two food containers. **5**

<p>DANGER</p> <p>This food may contain substances that can cause allergic reactions in some people.</p>	<p>Ingredients: Corn and/or Rice, Vegetable Oil, Skim Milk Powder, Whole Milk Powder, Cheese Powder (3.0%), Salt, Whey Powder, Yeast and/or Extracts, Hydrolysed Vegetable Protein, Flavour Enhancers (621, 631, 627), Food Acids (262, 270, 330, 331), Mineral Salt (339), Flavours, Anti-Caking Agent (504), Onion Powder, Herbs, Spices and/or Extracts, Antioxidants (304, 306).</p> <p>No Preservatives. No Artificial Colours. No Artificial Flavours.</p>
Food Label 1	Food Label 2

Discuss the usefulness of these labels, and explain how they can be improved.

- (c) Discuss the addition of substances to improve the appearance and shelf-life of cosmetic products. **7**
- (d) (i) Distinguish between the roles of preservatives and additives used in foods. **2**
- (ii) In your study of Preservatives and Additives, you carried out a first-hand investigation to compare the solubilities of preservatives such as nitrates, nitrites and sulfites. Outline your investigation, including the procedure used and a summary of your results. **3**
- (iii) How does the solubility of the compounds you investigated relate to their role as preservatives in cured meats? **3**

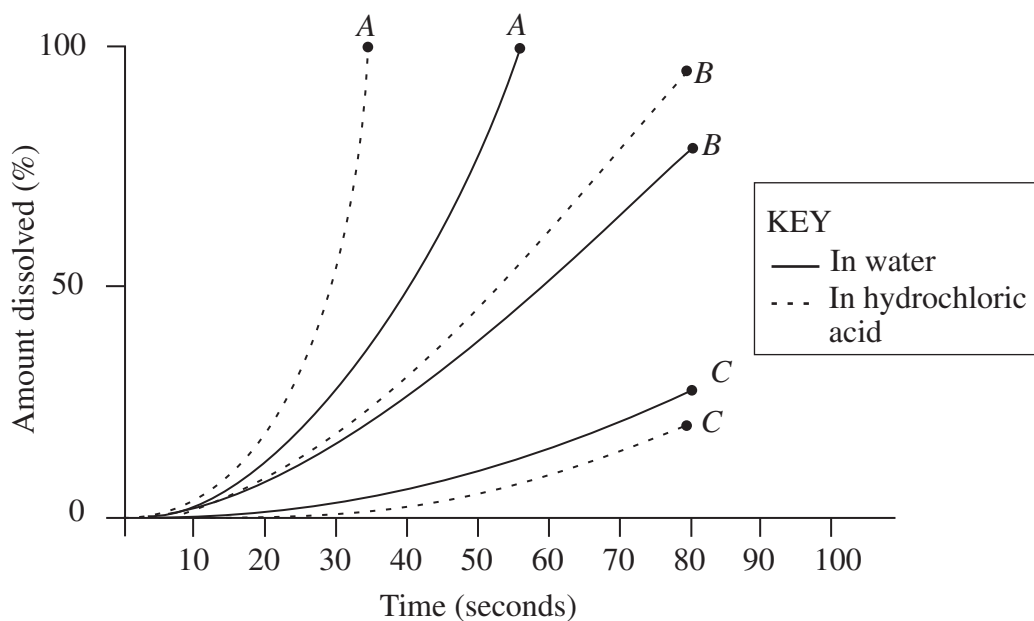
Question 30 — Pharmaceuticals (25 marks)

(a) The diagram shows a bacterium.



- (i) Identify the type of bacterium shown. 1
- (ii) Name the process by which bacteria reproduce, and use a diagram to illustrate this process. 3

(b) Jessica and William carried out an investigation to test the solubility of analgesics in water and hydrochloric acid. They chose the same brand in three different forms *A*, *B* and *C*. The results were graphed as follows.



- (i) Identify the form of analgesic used in the investigation that would dissolve fastest in the stomach. 1
- (ii) Discuss why analgesics are dispensed in different forms by relating their solubility to their form. 5

Question 30 continues on page 26

Question 30 (continued)

- (c) Evaluate the effectiveness of the circulatory system in transporting pharmaceuticals around the body. **7**
- (d) In your study of Pharmaceuticals, you carried out a first-hand investigation to demonstrate differences in reaction time.
- (i) Identify the main sense organ involved in your investigation. **1**
 - (ii) Draw a flowchart to illustrate the sequence of events in your investigation. **3**
 - (iii) Assess the validity of the conclusion you made from the data you collected. **4**

End of Question 30

Question 31 — Disasters (25 marks)

- (a) Natural disasters are commonplace in Australia.
- (i) Identify ONE specific example of a natural disaster that has occurred in Australia. **1**
 - (ii) As a consequence of this disaster, what techniques have been employed to reduce the incidence of future damage in similar events? **3**

(b) The photographs relate to some natural disasters.



Tropical cyclone

Earthquake

Bushfire

© Getty Images

- (i) Compare the effectiveness of named technological monitoring systems used to predict earthquakes and tropical cyclones. **3**
 - (ii) Identify ONE help service responsible for bushfire risk reduction, and describe TWO ways in which it attempts to reduce this risk. **3**
- (c) Evaluate the precautions that can be taken to minimise the likelihood of damage resulting from bushfires. **7**
- (d)
- (i) Name ONE type of fire on which a water-based extinguisher must NOT be used. **1**
 - (ii) Name another type of fire extinguisher, and identify a specific use of this extinguisher. **2**
 - (iii) In your study of Disasters, you performed a first-hand investigation to construct a working alarm or safety device. Using a labelled diagram, outline the construction of your working alarm or safety device and describe how you tested its effectiveness. **5**

Question 32 — Space Science (25 marks)

(a) The Space Transport System (STS), commonly called the Shuttle is used to transport people and materials into space.

(i) Identify ONE advantage of using a shuttle. 1

(ii) Explain how a shuttle overcomes ONE problem of lift-off. 3

(b) Space technologies can impact on other aspects of society.

An alloy of nickel and titanium, called Nitinol, was developed by NASA for use in the construction of antennas for spacecraft. Nitinol has exceptional elasticity that allows the alloy to return to its original shape after bending.

Straightening of teeth is a difficult process requiring many months of applying and regularly adjusting corrective wire braces. Nitinol has been used to help reduce the number of brace changes by exerting a continuous pull on teeth and in some cases reducing the length of time that braces need to be worn.

(i) Use the above information to identify the spin-off from the space program, and ONE impact this spin-off has had on society. 2

(ii) Identify TWO materials used in space suits, and relate the properties of these materials to the conditions that astronauts may experience in space. 4

(c) The Earth’s atmosphere and ‘empty space’ differ widely in terms of the distribution and concentration of gas particles. Analyse the concepts of atmosphere and ‘empty space.’ 7

Question 32 continues on page 29

Question 32 (continued)

- (d) Scientists carried out an investigation into the effect of a low gravity environment on the muscle mass of rats.

Two groups of rats were used in the investigation. *Group 1* remained on Earth, and *Group 2* were sent into space for six days. All other variables were kept constant for both groups.

The table shows the results of the investigation after six days.

	<i>Group 1</i>	<i>Group 2</i>	<i>Difference (%)</i>
<i>Animal mass (g)</i>	233 ± 8	216 ± 4	-7.3
<i>Soleus muscle mass (mg)</i>	102 ± 8	75 ± 8	-26.5

The soleus muscle is a muscle from the lower leg of a rat and is used to resist gravity.

- (i) What is the range of soleus muscle mass of rats that participated in the six-day space flight? (Include units in your answer.) **1**
- (ii) Why were two groups of rats used, rather than determining the mass of one group before and after the flight? **2**
- (iii) Explain why there was a greater percentage difference in the soleus muscle mass than in the animal mass. **5**

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