

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

**2007**

**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 21

**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 23–36

**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 for Questions 1–15.

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**1** Which alternative best describes healthy skin?

|     | <i>Classification</i> | <i>pH value</i> |
|-----|-----------------------|-----------------|
| (A) | Acidic                | 4.5–5           |
| (B) | Alkaline              | 4.5–5           |
| (C) | Acidic                | 7–8             |
| (D) | Neutral               | 7               |

**2** What is a role of microflora on human skin?

- (A) To produce hormones
- (B) To control body temperature
- (C) To protect the body from disease
- (D) To regulate the production of oils

**3** What is the main purpose of surfactants in shampoo?

- (A) To emulsify oil and dirt
- (B) To increase the shine of hair
- (C) To improve the appearance of shampoo
- (D) To increase the foaming power of shampoo

4

*Beauty Potion  
Number 9*

Non-greasy Moisturiser

Ingredients: water, oil,  
colour, fragrance

Why would this moisturiser feel non-greasy on the skin?

- (A) It is a suspension.
- (B) It is a water-in-oil emulsion.
- (C) It is an oil-in-water emulsion.
- (D) The oil evaporates after application.

5 Which alternative identifies the features of a solution?

|     | <i>Scatters light</i> | <i>Uniform throughout</i> | <i>Particles filter out</i> | <i>Particles settle into layers</i> |
|-----|-----------------------|---------------------------|-----------------------------|-------------------------------------|
| (A) | No                    | No                        | No                          | No                                  |
| (B) | Yes                   | No                        | Yes                         | Yes                                 |
| (C) | Yes                   | Yes                       | No                          | No                                  |
| (D) | No                    | Yes                       | No                          | No                                  |

6 What is a structural characteristic of alveoli?

- (A) Flexible cartilage
- (B) Large surface area
- (C) Tough muscular tissue
- (D) Thick coating of mucus

7 Jake could not find his two front teeth after they were knocked out in an accident.

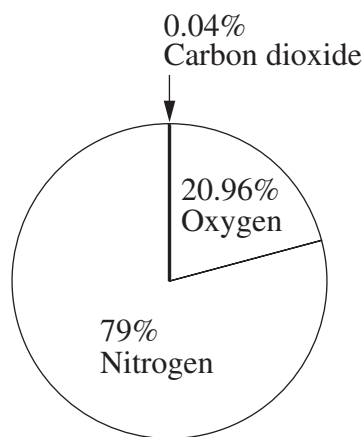
Which biomedical device would the dentist use to replace the lost teeth?

- (A) Crown
- (B) Denture
- (C) Pin
- (D) Screw

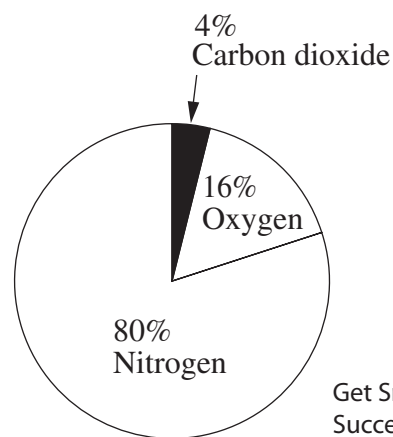
8 Why would a doctor decide to fit a 75-year-old patient with a cemented hip replacement?

- (A) Bone growth decreases with age.
- (B) Bone growth increases with age.
- (C) Cemented implants allow for bone growth.
- (D) Non-cemented implants put more pressure on the bone.

9 The pie charts represent the differences in the concentration of the three main gases in inhaled and exhaled air.



**Inhaled air**



**Exhaled air**

Get Smart You will Succeed: Senior Science, V. Smith, Science Press, 2003

What is the best conclusion you can draw from the information given above?

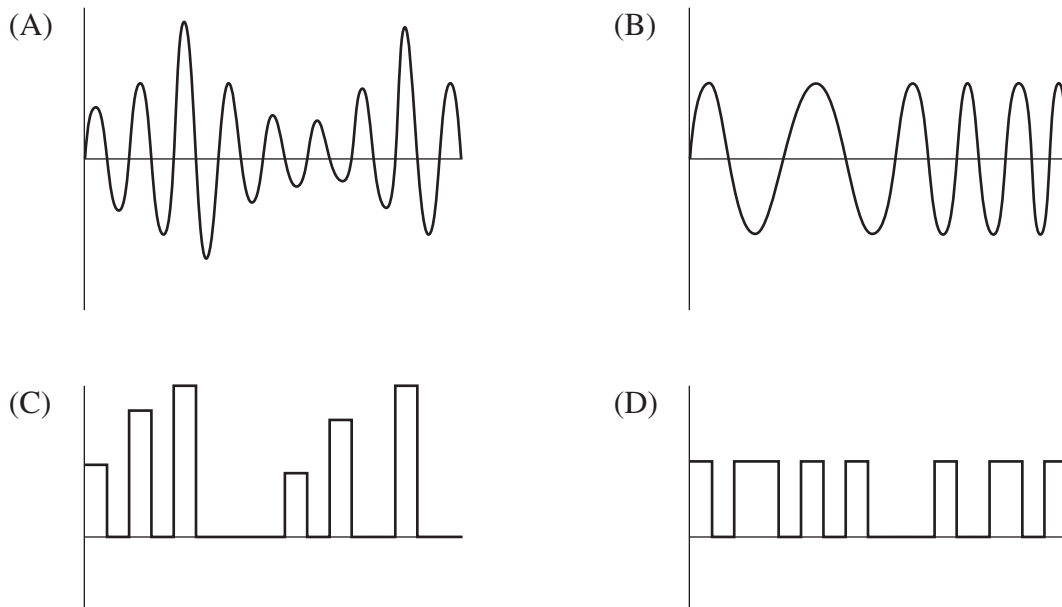
- (A) The concentration of oxygen has changed the least.
- (B) Oxygen concentration is greater in exhaled air than inhaled air.
- (C) Carbon dioxide concentration is greater in inhaled air than exhaled air.
- (D) The concentration of carbon dioxide is 100 times greater in exhaled air than inhaled air.

- 10 What will happen as a result of faulty heart valves?
- (A) The heart rate will slow down.
  - (B) Blood will flow from the atria into the arteries.
  - (C) Blood will flow from the ventricles into the atria.
  - (D) The heart will not contract with a regular rhythm.

11 Which of the following correctly classifies the information system?

|     | <i>Information system</i> | <i>Verbal or non-verbal</i> | <i>Long or short distance</i> | <i>Electronic or non-electronic</i> |
|-----|---------------------------|-----------------------------|-------------------------------|-------------------------------------|
| (A) | Drums                     | Verbal                      | Long distance                 | Non-electronic                      |
| (B) | Mobile phone              | Verbal                      | Long distance                 | Electronic                          |
| (C) | School loudspeaker        | Verbal                      | Short distance                | Non-electronic                      |
| (D) | TV                        | Non-verbal                  | Long distance                 | Electronic                          |

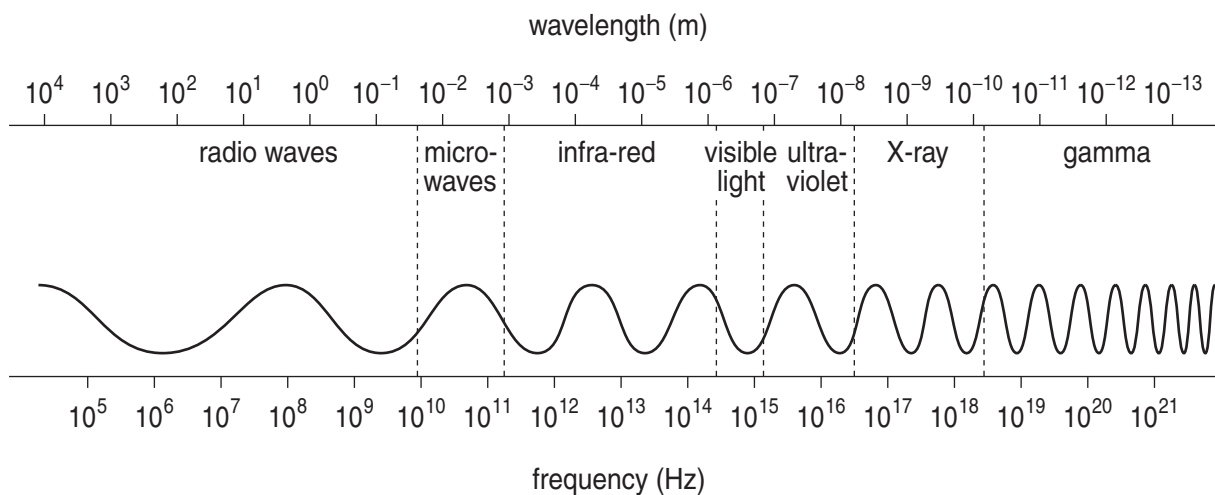
12 Which graph best represents a digital code?



13 Which sequence best represents information transfer in telephone communication?

- (A) Message → code → decoder → transmission → message
- (B) Message → decoder → transmission → code → message
- (C) Message → code → transmission → decoder → message
- (D) Message → transmission → code → decoder → message

Questions 14 and 15 refer to the following diagram of the electromagnetic spectrum.

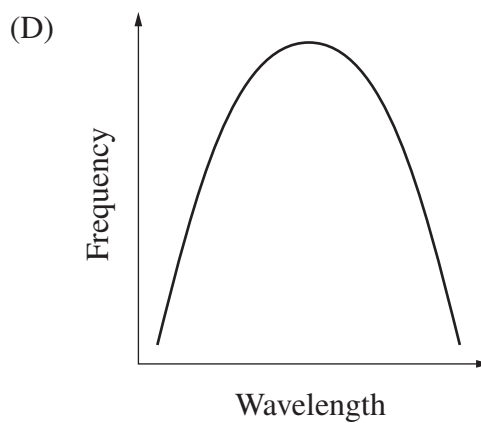
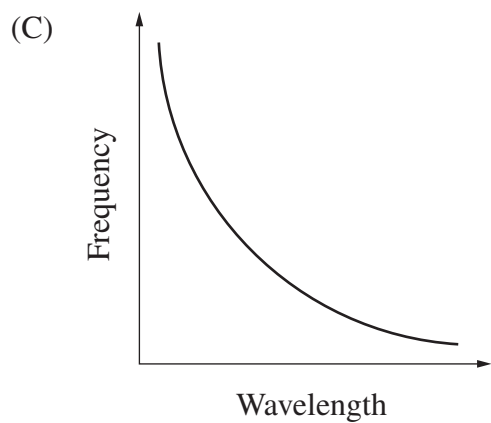
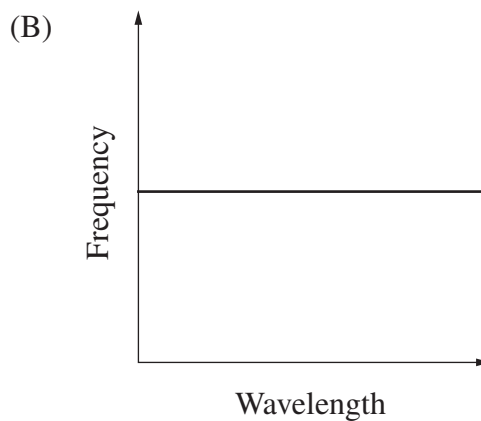
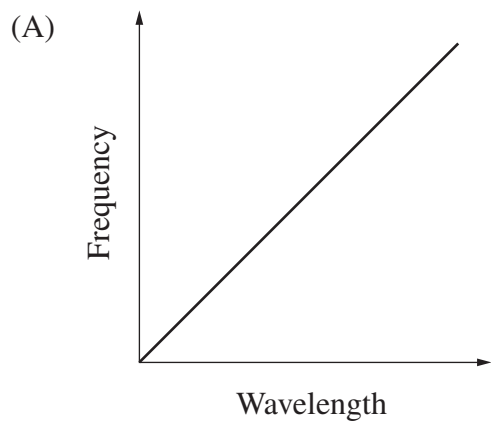


14 Which alternative identifies the section of the electromagnetic spectrum used for communication purposes?

|     | <i>Wavelength (m)</i>  | <i>Frequency (Hz)</i> |
|-----|------------------------|-----------------------|
| (A) | Less than $10^{-3}$    | Less than $10^{11}$   |
| (B) | Greater than $10^{-3}$ | Less than $10^{11}$   |
| (C) | Less than $10^{-7}$    | Less than $10^{15}$   |
| (D) | Greater than $10^{-7}$ | Less than $10^{15}$   |

Surfing: Senior Science Information Systems,  
David Heffernan, Science Press, 2003

15 Which graph best represents the relationship between frequency and wavelength as shown in the electromagnetic spectrum?



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Section I (continued)

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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.

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**Question 16** (3 marks) **Marks**

(a) Define the term *solvent*. **1**

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(b) Complete the table by giving examples of cosmetics and external medications using water and alcohol as solvents. **2**

| <i>Solvent</i> \ <i>Use</i> | <i>Cosmetic</i> | <i>External medication</i> |
|-----------------------------|-----------------|----------------------------|
| Water                       |                 |                            |
| Alcohol                     |                 |                            |

**Question 17** (4 marks)

‘All emulsions are colloids; but not all colloids are emulsions.’

**4**

Justify this statement with reference to specific examples of colloids and emulsions.

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**Question 18** (4 marks)

Discuss the use of soapless detergents in body cleaning products.

**4**

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**Question 19** (5 marks)

Relate the properties of pesticides and body hygiene products to the precautions needed when using and handling each type of chemical.

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Section I – Part B (continued)

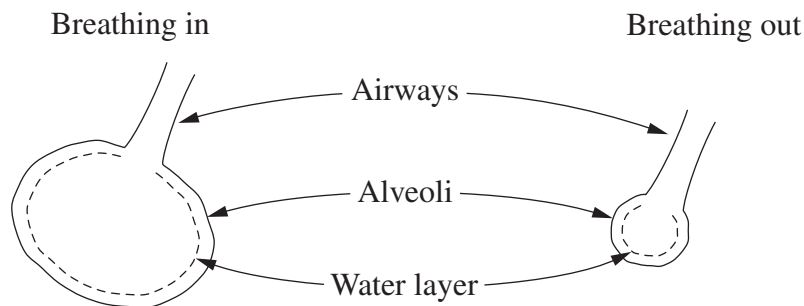
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Question 20 (5 marks)

Air in the lungs is full of water vapour, which coats the alveoli in a thin layer. The water in this layer helps to reduce the diameter of the alveoli, which pushes some air out. To prevent the alveoli from collapsing completely, they produce surfactant. If the alveoli collapse, they are unable to fill with air.



- (a) Explain how the water layer reduces the diameter of the alveoli to make them smaller. 2

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- (b) Scientists have found that cigarette smokers have less surfactant in their lungs than non-smokers. 3

Explain the effect of the reduction in surfactant on the breathing of cigarette smokers.

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**Question 21** (7 marks)

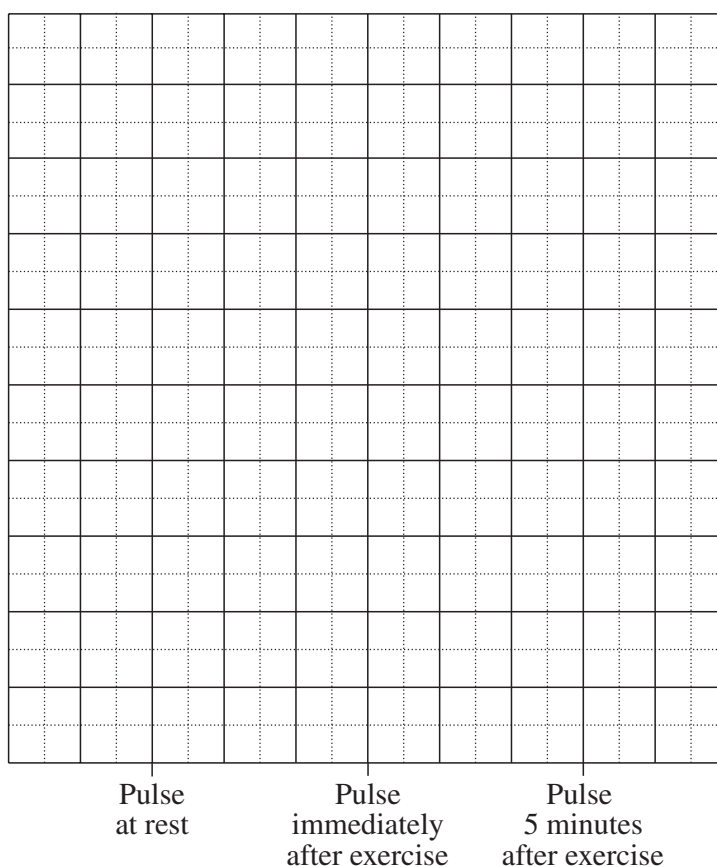
Some students were asked to plan and perform a first-hand investigation to determine the time it takes for the heart to return to its resting rate after exercise. Heart rate is measured in beats per minute (bpm).

After completing their experiment, the students produced the following results table.

| <i>Student</i> | <i>Pulse at rest before exercise (bpm)</i> | <i>Pulse immediately after exercise (bpm)</i> | <i>Pulse 5 minutes after exercise (bpm)</i> |
|----------------|--|---|---|
| 1              | 50   | 140   | 95  |
| 2              | 70   | 190   | 160   |
| 3              | 70   | 130   | 80  |
| 4              | 80   | 90  | 80  |

(a) Using the grid, draw a graph of these results. Provide a key.

3



**Question 21 continues on page 15**

Question 21 (continued)

- (b) Explain how the design of the investigation could be modified to improve the validity of the data collected. **4**

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**End of Question 21**

**Question 22** (6 marks)

A sketch of a bone that has been cut through the middle is shown.



- (a) Identify part *X*, and outline its role in the operation of joints. **2**

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- (b) Justify the use of ultrahigh molecular weight polyethylene (UHMWPE) as a replacement for part *X*. **4**

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**Section I – Part B (continued)**

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**Question 23** (6 marks)

Non-invasive medical techniques have been developed to reduce the risks to patients while diagnosing their medical problems. **6**

Evaluate this statement, using specific examples.

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**Question 24** (6 marks)

- (a) Outline the principle of total internal reflection. **2**

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- (b) Explain reasons for the increased use of fibre optics in communication. **4**

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**Question 25** (4 marks)

Relate TWO properties of microwaves to their use in communication through air and space.

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Section I – Part B (continued)

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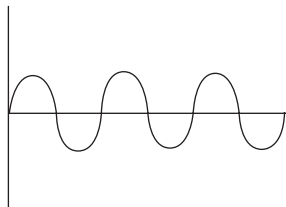
Student Number

**Marks**

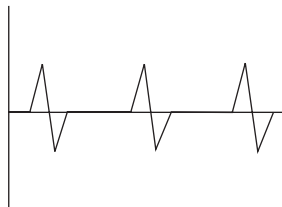
**Question 26** (4 marks)

A student carried out a first-hand investigation to observe ways in which waves can be modulated to carry information.

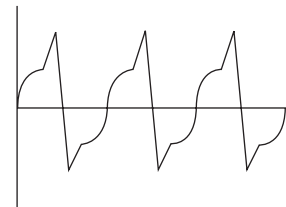
When a microphone was connected to a cathode ray oscilloscope (CRO), the oscilloscope produced different electrical signals depending on the input waves. Three electrical signals produced by different input waves are shown.



A tuning fork



A person's voice



A tuning fork  
and a person's voice

(a) What type of modulation has been demonstrated?

**1**

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(b) Explain how the results of this investigation demonstrate the process of modulation.

**3**

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Question 27 (6 marks)

Assess the impacts that changes in communication systems have had on society.

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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.

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|  | Pages |
|--|-------|
| Question 28    Polymers .....                    | 24–25 |
| Question 29    Preservatives and Additives ..... | 26–28 |
| Question 30    Pharmaceuticals .....             | 29–31 |
| Question 31    Disasters .....                   | 32–34 |
| Question 32    Space Science .....               | 35–36 |

**Question 28 — Polymers (25 marks)**

- (a) (i) How are polymers formed? 1
- (ii) Copy and complete the table in your writing booklet. 4

| <i>Polymer</i> | <i>Property</i> | <i>Use</i> |
|----------------|-----------------|------------|
| PVC            |                 |            |
| Polyethylene   |                 |            |

- (b) A manufacturer has tested three natural materials. The material is to be used in a new collection of children’s summer sleepwear and so must be durable and safe.

| <i>Property</i>         | <i>Wool</i> | <i>Silk</i> | <i>Cotton</i> |
|-------------------------|-------------|-------------|---------------|
| Thermal properties      | excellent   | good        | fair          |
| Strength                | fair        | excellent   | good          |
| Resistance to shrinking | average     | good        | poor          |
| Moisture absorbency     | excellent   | excellent   | good          |

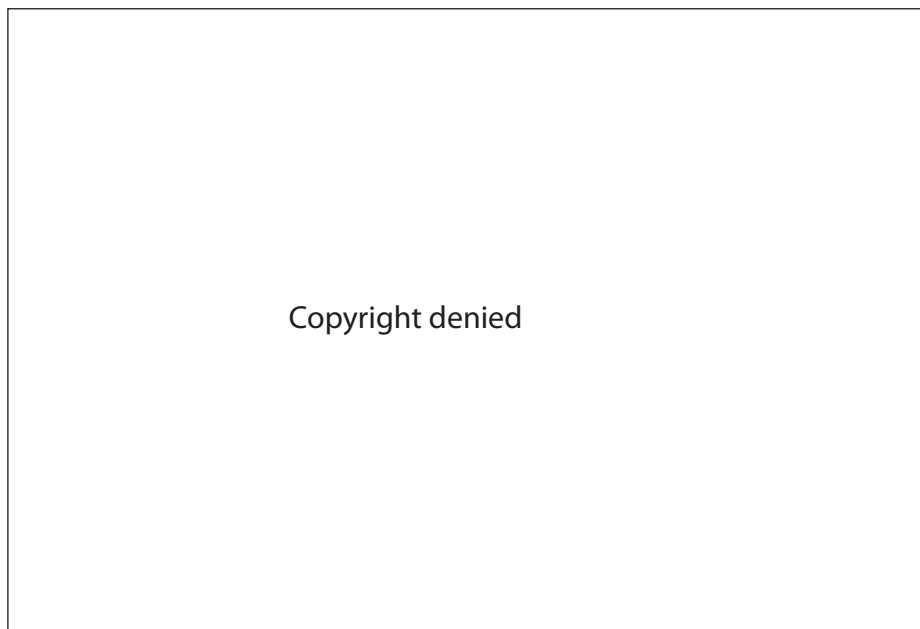
- (i) What is the most suitable natural material? Justify your selection. 4
- (ii) Propose another property which should have been tested to meet the manufacturer’s requirements. Give a reason for your answer. 2
- (c) Discuss the effects on the environment of using synthetic polymers. 6

**Question 28 continues on page 25**



Question 28 (continued)

(d) The following article was published on the internet.



- (i) Outline how you would assess the reliability of the information presented in this article. **2**
- (ii) Design a first-hand investigation to test one of the claims made in this article. **4**
- (iii) Propose future directions of research relating to plastic containers. **2**

**End of Question 28**

**Question 29 — Preservatives and Additives (25 marks)**

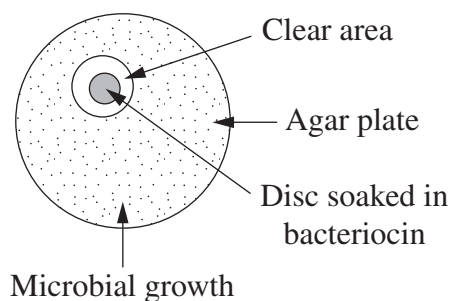
- (a) (i) How do preservation techniques increase the shelf life of food? **1**
- (ii) Copy and complete the table in your writing booklet. **4**

| <i>Preservation method</i> | <i>Example of method</i> | <i>Type of food preserved</i> |
|----------------------------|--------------------------|-------------------------------|
| Physical                   |                          |                               |
| Chemical                   |                          |                               |

- (b) Four new types of bacteriocins are being investigated for use in some freshly squeezed orange juices.

To test the effectiveness of the bacteriocin, a small disc of paper which has been soaked in the bacteriocin is placed onto the surface of an agar plate. The agar plate has thousands of micro-organisms growing on it and looks cloudy.

If the bacteriocin works, the area around the disc will become clear where the micro-organisms have died.



**Question 29 continues on page 27**

## Question 29 (continued)

The table below shows the results for four new bacteriocins.

| <i>Bacteriocin</i> | <i>Micro-organisms most affected</i> | <i>Clear area after 2 days (mm)</i> | <i>Clear area after 4 days (mm)</i> |
|--------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| A                  | moulds, yeasts                       | 0                                   | 0                                   |
| B                  | bacteria                             | 20                                  | 0                                   |
| C                  | bacteria                             | 10                                  | 10                                  |
| D                  | moulds, yeasts                       | 10                                  | 20                                  |

- (i) Which bacteriocin would be the most suitable for use in freshly squeezed orange juice? Justify your choice. **4**
- (ii) Propose another condition which should be considered when choosing the bacteriocin. Give a reason for your answer. **2**
- (c) Discuss the impacts on society of Government food labelling regulations. **6**

**Question 29 continues on page 28**

## Question 29 (continued)

- (d) The following article was published on the internet.

**Eating out a danger**

Fast food restaurants and salad bars, rare 50 years ago, are today a primary source of food consumption for many Australians. In Australia, it is estimated that the number of food service outlets has grown 57 per cent with Australians spending 30 per cent of their food budget on take-away food and dining out.

Around sixty to eighty per cent of foodborne illnesses arise from take-away food or dining out.

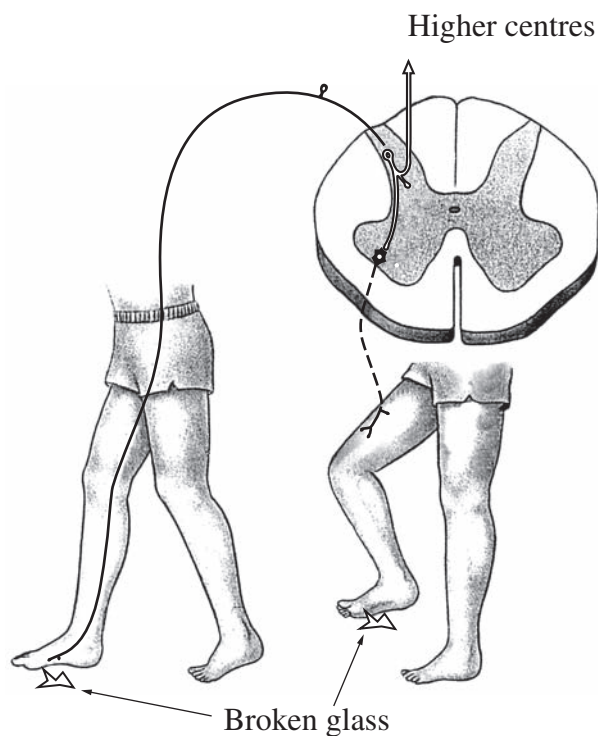
Studies in New South Wales have shown that a history of eating out in the week before the onset of gastroenteritis was associated with a significantly increased yield of *Salmonella* and *Campylobacter*. Consequently, with the increasing trend towards take-away food and dining out, there is the likelihood of increasing numbers of people contracting foodborne illnesses.

- |  |          |
|--|----------|
| (i) Outline how you could assess the reliability of the information presented in this article. | <b>2</b> |
| (ii) Design a first-hand investigation to test one of the claims made in this article.         | <b>4</b> |
| (iii) Propose future directions of research relating to the incidence of foodborne illnesses.  | <b>2</b> |

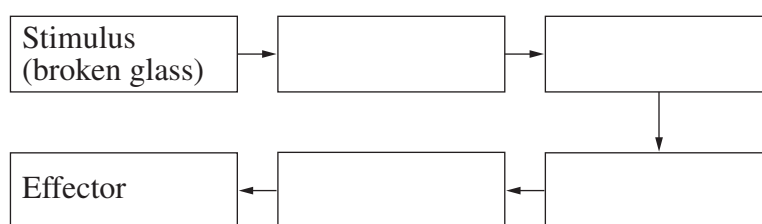
**End of Question 29**

**Question 30 — Pharmaceuticals (25 marks)**

- (a) Zac stood on some broken glass. The following diagram shows a nerve pathway (not to scale) from an area of skin that was cut.



- (i) What is this type of nerve pathway called? 1
- (ii) Copy and complete the flow chart in your writing booklet. 4



**Question 30 continues on page 30**

## Question 30 (continued)

- (b) A student carried out a first-hand investigation to determine the rate of solubility of a range of analgesics at different pH levels. The student recorded the time taken for the analgesic to fully dissolve under each condition.

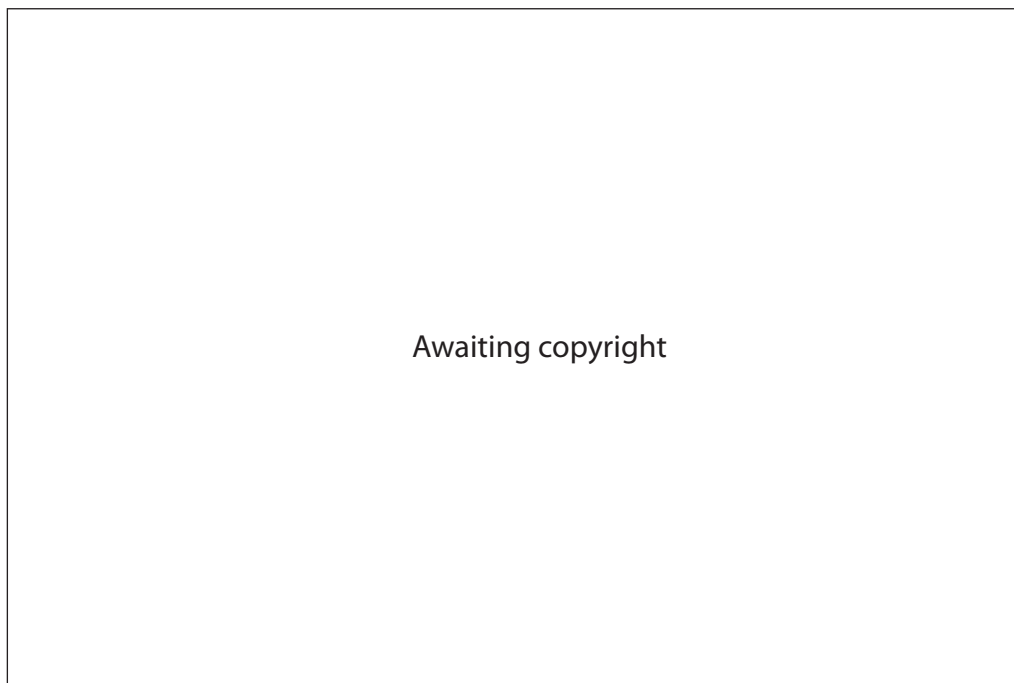
| <i>Analgesic</i> | <i>Dispensing form</i> | <i>Time to dissolve (minutes)</i> |                    |                              |
|------------------|------------------------|-----------------------------------|--------------------|------------------------------|
|                  |                        | <i>pH3 (stomach)</i>              | <i>pH7 (mouth)</i> | <i>pH9 (small intestine)</i> |
| A                | Soluble                | 10                                | 25                 | 30                           |
| B                | Soluble                | 15                                | 20                 | 25                           |
| C                | Capsule                | 10                                | not soluble        | not soluble                  |
| D                | Enteric-coated         | not soluble                       | not soluble        | 5                            |

- (i) Select the analgesic that would provide the fastest pain relief. Justify your answer. **4**
- (ii) Propose another condition that could be tested to determine how quickly an analgesic will be absorbed by the body. **2**
- (c) Assess the impacts on society of increased bacterial resistance to antibiotics. **6**

**Question 30 continues on page 31**

Question 30 (continued)

(d) The following article was published on the internet.



- |   |          |
|---|----------|
| (i) Outline how you could assess the reliability of the information presented in this article.      | <b>2</b> |
| (ii) Design a first-hand investigation to test one of the claims made in this article.              | <b>4</b> |
| (iii) Outline the contribution of one scientist to our understanding of disease caused by bacteria. | <b>2</b> |

**End of Question 30**

**Question 31 — Disasters (25 marks)**

- (a) (i) What is an isobar? **1**
- (ii) Copy and complete the table in your writing booklet, identifying technologies used to produce weather maps. **4**

| <i>Technology used</i> | <i>Type of data collected</i> |
|------------------------|-------------------------------|
|                        |                               |
|                        |                               |

**Question 31 continues on page 33**

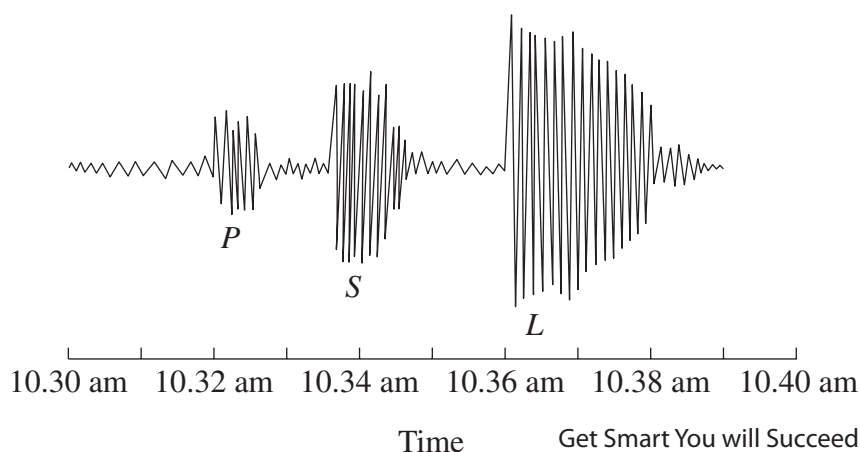


Question 31 (continued)

(b) The table shows some properties of three types of earthquake waves.

| <i>Type of wave</i> | <i>Average speed of travel (km/s)</i> | <i>Average level of damage</i> |
|---------------------|---------------------------------------|--------------------------------|
| <i>P</i>            | 9                                     | minor                          |
| <i>S</i>            | 5                                     | moderate                       |
| <i>L</i>            | 3                                     | major                          |

This seismograph was produced when an earthquake hit a densely populated city at 10.30 am on a weekday.



Get Smart You will Succeed: Senior Science, V. Smith, Science Press, 2003

- (i) Using the seismograph and the table, calculate the distance (speed  $\times$  time) between the epicentre and the seismometer which produced this seismograph. Show all working. 2
- (ii) Propose TWO hazards that may be faced by emergency services as they carry out their role after the earthquake. Give reasons for your answer. 4

**Question 31 continues on page 34**

Question 31 (continued)

- (c) Discuss the impacts on society of warning devices that can be used to detect disasters. **6**
- (d) The following article was published on the internet.



- (i) Outline how you would assess the reliability of the information presented in this article. **2**
- (ii) Design a first-hand investigation to test one of the claims made in this article. **4**
- (iii) Propose future directions of research into the control and prevention of bushfires. **2**

**End of Question 31**

**Question 32 — Space Science (25 marks)**

- (a) (i) What is the force that keeps Earth's atmosphere in place? **1**
- (ii) Draw diagrams in your writing booklet to model the relative distance of particles in a solid, a liquid, a gas and in space. **4**
- (b) When astronauts go into space they still need to exercise in order to minimise the loss of their muscle mass.

The table shows the results of the exercise program of four astronauts. Each type of exercise (W, X, Y, Z) focused on a different set of muscles.

| <i>Astronaut</i> | <i>Time spent on exercise each day (minutes)</i> |          |          |          | <i>Muscle mass lost (%)</i> |
|------------------|--|----------|----------|----------|-----------------------------|
|                  | <i>W</i>   | <i>X</i> | <i>Y</i> | <i>Z</i> |                             |
| 1                | 10   | 10       |          | 10       | 5                           |
| 2                |  | 10       | 10       | 10       | 7                           |
| 3                | 20   | 20       |          |          | 5                           |
| 4                |  |          | 20       | 20       | 8                           |

- (i) Which exercise program would be the most appropriate for minimising the loss of muscle mass? Justify your choice. **4**
- (ii) Propose another body system which would need to be maintained in order to allow the astronauts to live a normal life on their return to Earth. Give a reason for your answer. **2**
- (c) Assess the impact on society of space research and exploration programs. **6**

**Question 32 continues on page 36**

## Question 32 (continued)

- (d) The following article was published on the internet.

**Write in Space**

The amazing Space Pen® was adopted by scientists at NASA who needed to find a pen that would work in zero gravity. The pen has since been used successfully by several astronauts during missions on the space shuttle.

The Space Pen® is superior in design compared to other types of pens and this makes it a better pen for all applications.

The Space Pen® will write for twice as long as other types of pens and can write at any angle.

The amazing Space Pen® is now available to consumers and is less expensive than you may think. We guarantee that the amazing Space Pen® is the best pen that you will ever own.

- |   |          |
|---|----------|
| (i) Outline how you could assess the reliability of the information found in this article.                          | <b>2</b> |
| (ii) Design a first-hand investigation to test one of the claims made in this article.                              | <b>4</b> |
| (iii) Outline the contribution made by one space mission to our understanding of the solar system and the universe. | <b>2</b> |

**End of paper**

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