



NSW Education Standards Authority

2018 HIGHER SCHOOL CERTIFICATE EXAMINATION

Senior Science

**General
Instructions**

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESAs may be used

**Total marks:
100**

Section I – 75 marks (pages 2–32)

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1–20
- Allow about 35 minutes for this part

Part B – 55 marks

- Attempt Questions 21–30
- Allow about 1 hour and 40 minutes for this part

Section II – 25 marks (pages 33–41)

- Attempt ONE question from Questions 31–35
- Allow about 45 minutes for this section

Section I
75 marks

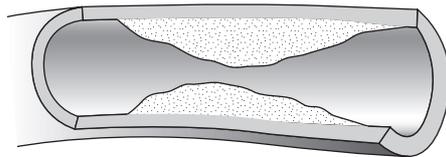
Part A – 20 marks

Attempt Questions 1–20

Allow about 35 minutes for this part

Use the multiple-choice answer sheet for Questions 1–20.

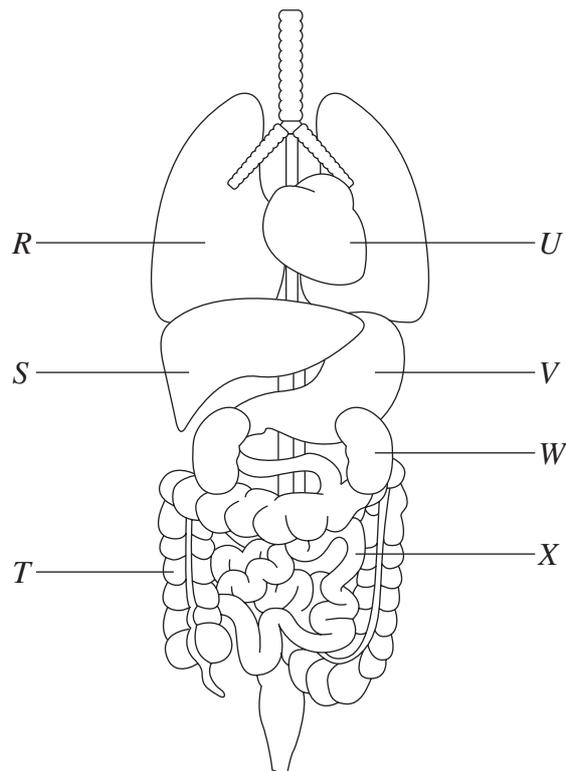
- 1 A cochlear implant is best classified as a
- A. non-invasive device.
 - B. UHMWPE implant.
 - C. biomedical device.
 - D. biometric implant.
- 2 Which feature is necessary for optical fibres to transmit information?
- A. Low transparency
 - B. Complete diffraction of light
 - C. Total internal reflection of light
 - D. Ability to convert light energy into electrical pulses
- 3 The diagram shows a cutaway view of an abnormal blood vessel.



The best way to treat the problem illustrated would be with

- A. angioplasty.
- B. a pacemaker.
- C. bronchial dilation.
- D. a polyethylene valve.

- 4 The diagram shows some organs of the human body.



Which set of labels identifies only organs of the digestive system?

- A. *R, T, V, X*
 - B. *S, T, U, V*
 - C. *T, V, W, X*
 - D. *S, T, V, X*
- 5 A student made observations and conclusions about four everyday consumer products that are mixtures.

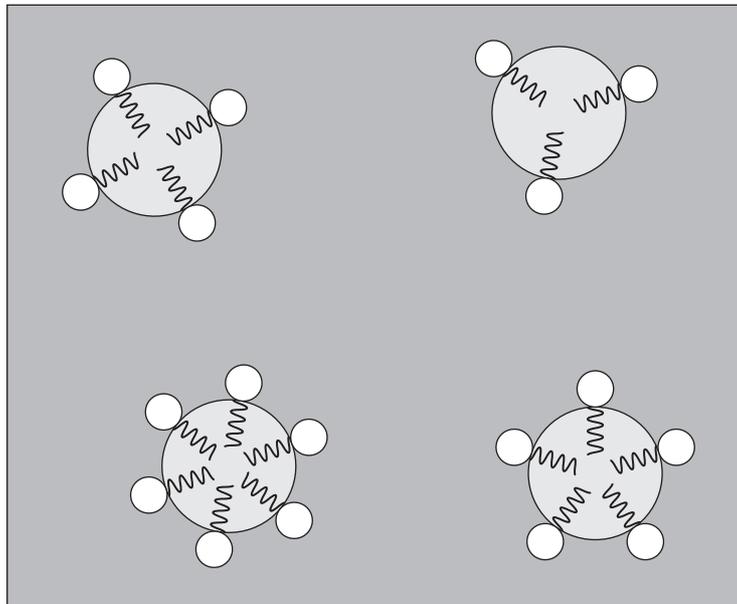
Which statement correctly relates her conclusion to her observation?

- A. Shampoo is a solution because it looks clear.
- B. Shower gel is an emulsion because it foams up in water.
- C. Mayonnaise is a suspension because oil is floating on top.
- D. Orange juice is a colloid because bits of orange settle to the bottom.

- 6 Which row of the table correctly identifies the conditions in the stomach and small intestine and the role of each organ?

	<i>Stomach</i>	<i>Small intestine</i>
A.	Neutral conditions Absorbs carbohydrates	Acidic conditions Secretes bile
B.	Low pH conditions Absorbs carbohydrates	High pH conditions Digests fats
C.	High pH conditions Churns up enzymes	Low pH conditions Secretes enzymes
D.	High acid conditions Breaks down proteins	Low acid conditions Digests fats

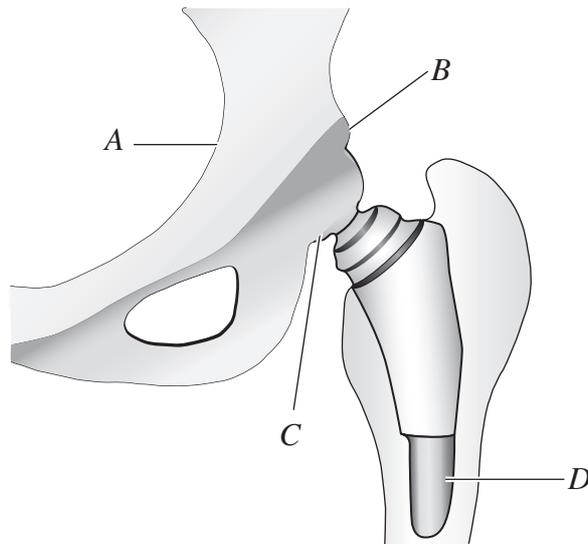
- 7 The following diagram was used to model a mixture.



Which mixture is best represented by this model?

- A. Mayonnaise
- B. Whisked eggs
- C. Alcohol/water
- D. Oil/vinegar salad dressing

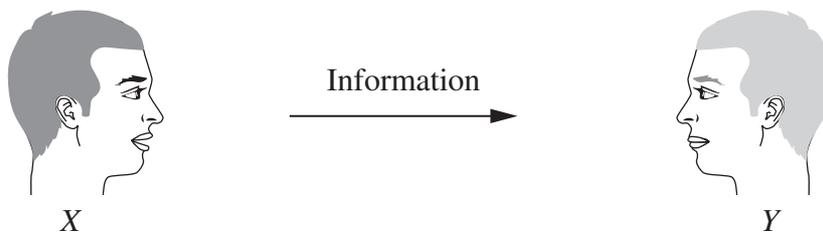
8 The following diagram shows an artificial hip joint.



Which part of the joint is most likely to be made of polyethylene?

- A. A
- B. B
- C. C
- D. D

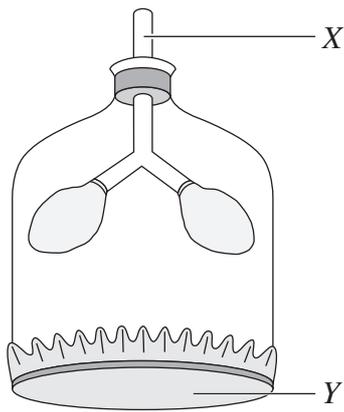
9 Information is transferred from X to Y as spoken words and facial expressions.



Which row of the table correctly identifies the method of transfer of the non-verbal component of information, and its decoder?

	<i>Method of transfer</i>	<i>Decoder</i>
A.	Sound wave	Ear
B.	Sound wave	Brain
C.	Electromagnetic wave	Eye
D.	Electromagnetic wave	Brain

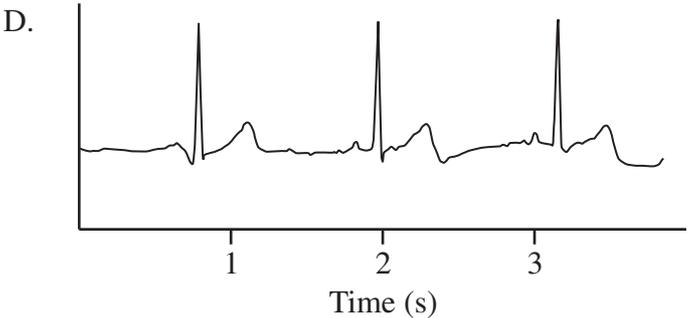
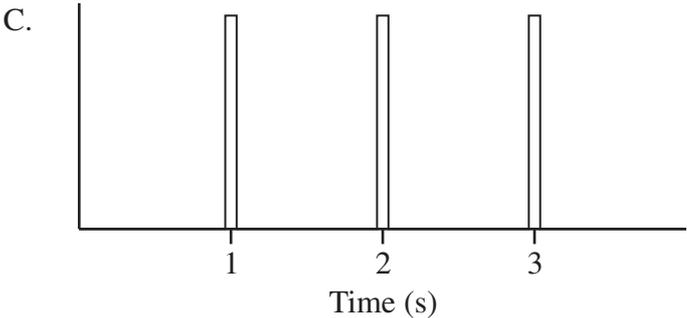
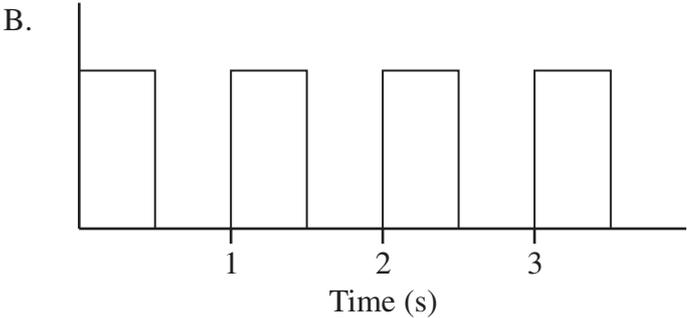
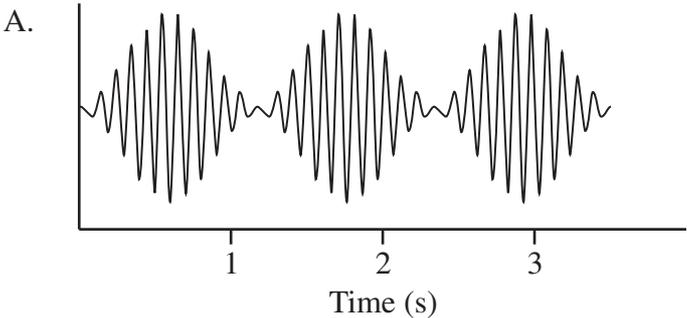
- 10 This model is used to demonstrate the operation of part of the human respiratory system.



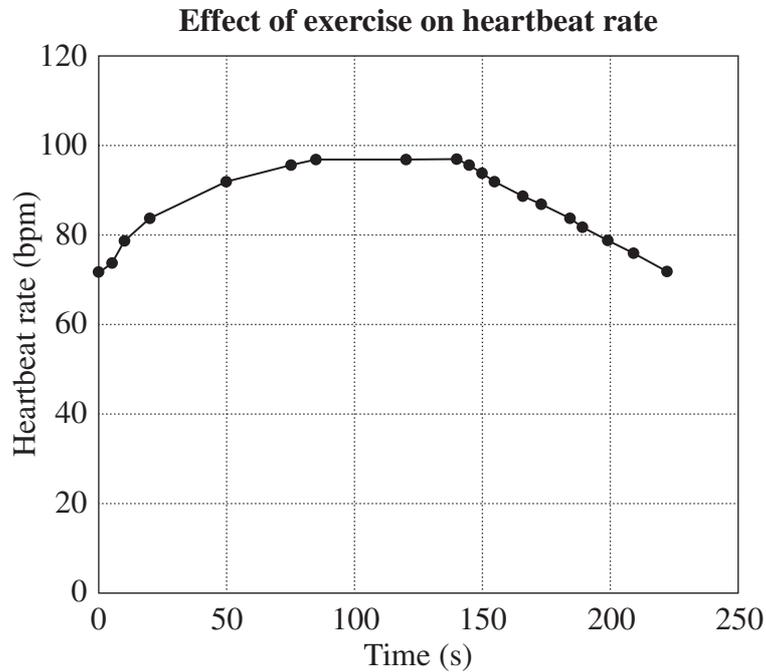
How could the process of inhalation be demonstrated using this model?

- A. Blowing into component *X*
- B. Sucking from component *X*
- C. Pushing up on component *Y*
- D. Pulling down on component *Y*

11 Which diagram shows the electrical output of a heart pacemaker?



- 12 A person pedalled at a constant rate for 140 seconds on an exercise bike. The person then stopped and rested. Heartbeat rate measurements were taken from the commencement of the exercise until the heartbeat rate returned to its resting rate. The measurements were graphed.

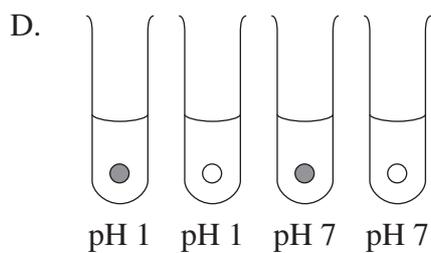
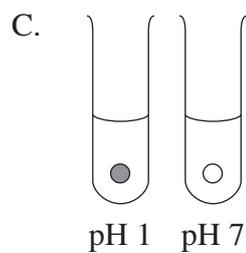
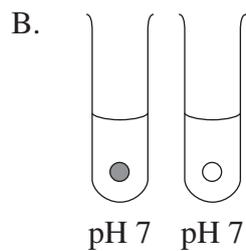
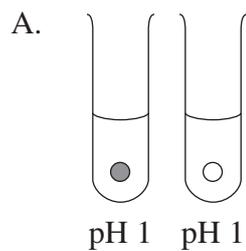


Which of the following can be concluded from the graph?

- A. After ceasing the exercise, the person's heartbeat rate decreased uniformly.
- B. A person's heartbeat rate continues to increase for as long as the person keeps exercising.
- C. Exercise causes a rapid increase in heartbeat rate because more oxygen is required by the muscles.
- D. The amount of carbon dioxide exhaled with each breath increased at a decreasing rate while the person was exercising.

- 13 A student planned a first-hand investigation to compare the rates at which tablets and enteric-coated tablets dissolve in the stomach.

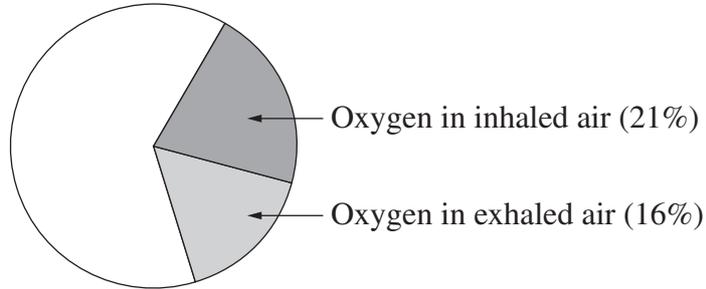
Which experimental method would be best to use for this investigation?



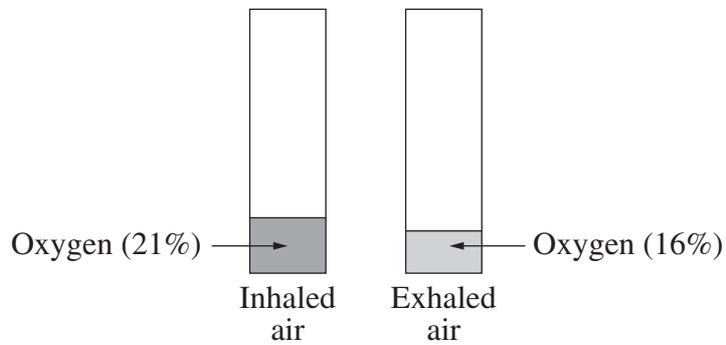
- 14 A student carried out a first-hand investigation to compare the oxygen content of inhaled air and exhaled air. Inhaled air contained 21% oxygen while exhaled air contained 16% oxygen.

Which of the following would be the most appropriate way to present the results?

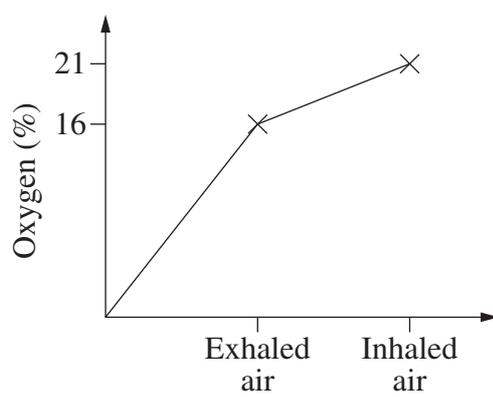
A.



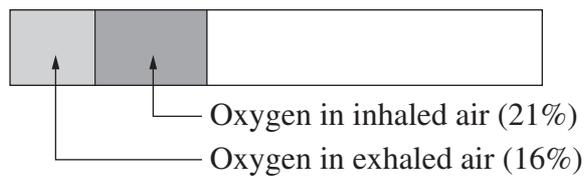
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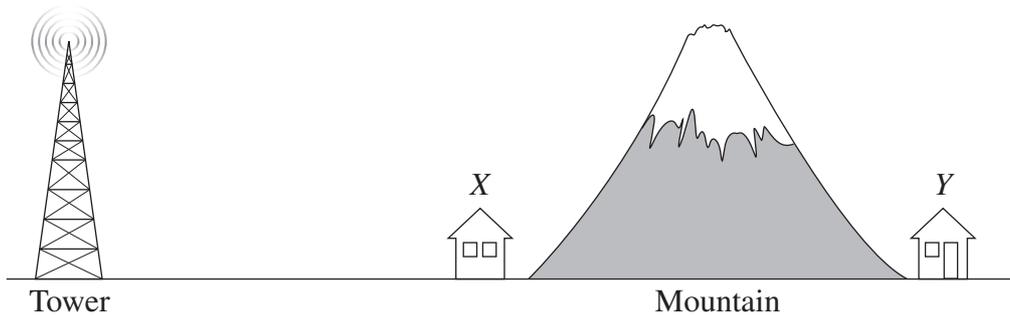
C.



D.



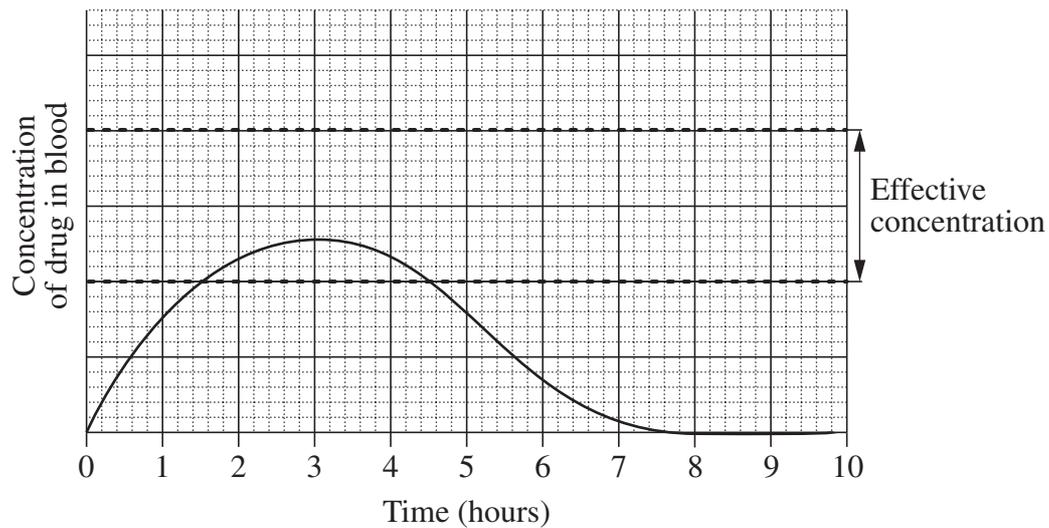
- 15 An AM radio transmitter and a microwave transmitter are broadcasting signals of equal strength from the same tower on a clear, dry day.



Which statement is correct about the signals received at house *X* or house *Y*?

- A. At house *Y* the AM radio signal will be stronger than the microwave signal because AM radio waves bend around mountains better than microwaves.
- B. At house *X* the microwave signal will be stronger than the AM radio signal because microwaves transmit through the atmosphere better than AM radio waves.
- C. At house *Y* the microwave signal will be stronger than the AM radio signal because microwaves bend around mountains better than AM radio waves.
- D. At house *X* the AM radio signal will be stronger than the microwave signal because AM radio waves transmit through the atmosphere better than microwaves.

- 16 The graph shows how the concentration of a drug in the bloodstream changes after a single dose.



- For how long will the drug be effective in the bloodstream?
- A. 1.5 hours
 - B. 3.0 hours
 - C. 4.5 hours
 - D. 7.5 hours
- 17 Doubling the distance from a source of electromagnetic radiation reduces the intensity of the radiation by a factor of four.

A light meter was used to measure the intensity of light at different distances from a source. At 120 cm from the source, the reading on the light meter was 2 units.

What would be the reading on the light meter at a distance of 30 cm from the source?

- A. 4
- B. 8
- C. 16
- D. 32

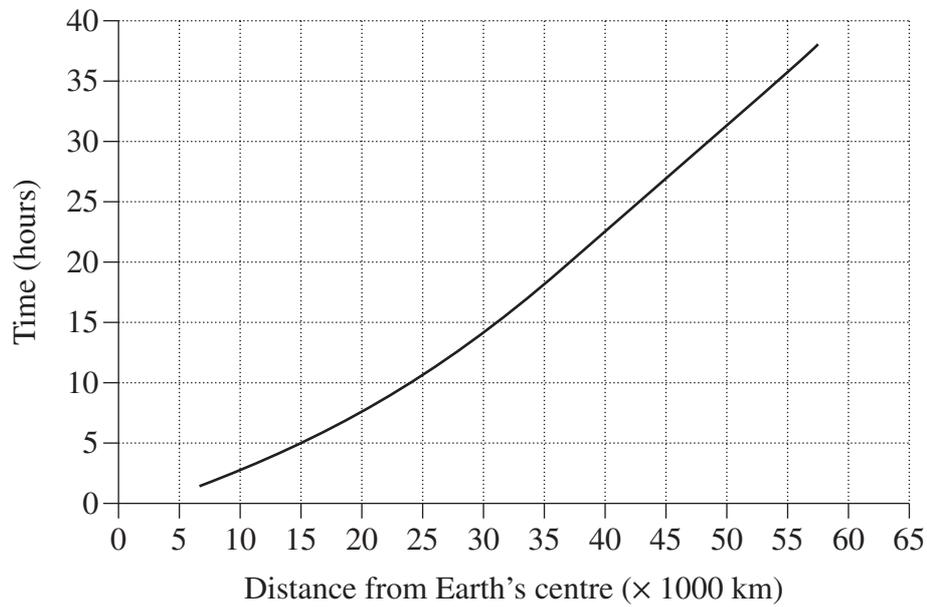
- 18** A student decides to scrub his skin three times a day for a month with an effective antibacterial water/alcohol mixture, leaving the treated skin to dry naturally.

Which statement explains the most likely outcome of following this procedure?

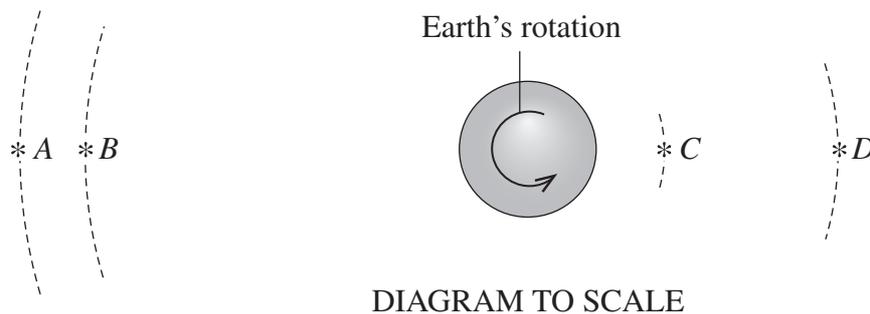
- A. The natural pH of his skin will decrease because microflora produce chemicals that make the skin less acidic.
- B. The temperature of his skin will become progressively lower because evaporating alcohol has a cooling effect on the skin.
- C. His skin may become infected with disease-causing fungi and bacteria because the balance of microflora will be altered.
- D. His skin will become progressively moister because of the water content of the mixture and alcohol being an effective humectant.

19 The graph shows the time it takes for satellites to travel around Earth in a circular orbit.

The radius of Earth is 6400 km.



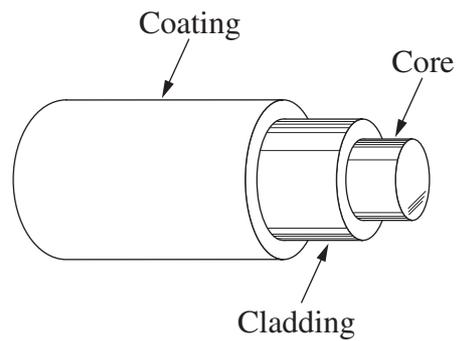
The following diagram shows part of the circular orbits of four satellites around Earth.



Using information from both the graph and the diagram, identify where a geostationary satellite must be located.

- A. A
- B. B
- C. C
- D. D

20 The diagram shows the cross-section of an optical fibre.



Information calculated from the speed of light and the properties of different media is shown in the table.

<i>Medium</i>	<i>Time taken for light to travel 1000 km in a straight line through the medium (ms)</i>
Air	3.3
Cladding	5.3
Core	5.0

An optical fibre 1000 km long connects two towns 900 km apart.

Which is the best estimate of the minimum time light would take to travel through the fibre between the two towns?

- A. < 4.5 ms
- B. 4.5 ms
- C. 5.0 ms
- D. > 5.0 ms

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Centre Number

Senior Science
Section I Part B
Answer Booklet

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Student Number

55 marks
Attempt Questions 21–30
Allow about 1 hour and 40 minutes for this part

- Instructions**
- Write your Centre Number and Student Number at the top of this page.
 - Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
 - Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Please turn over

Question 21 (4 marks)

(a) Identify TWO precautions that should be taken when using pesticides. 2

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(b) Explain why it is desirable for pesticides to be biodegradable. 2

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Question 22 (6 marks)

- (a) Explain ONE impact that a specific communication system has had on society. **2**

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- (b) In addition to using AM or FM waves, music can now be transmitted using digital radio or through the internet. **4**

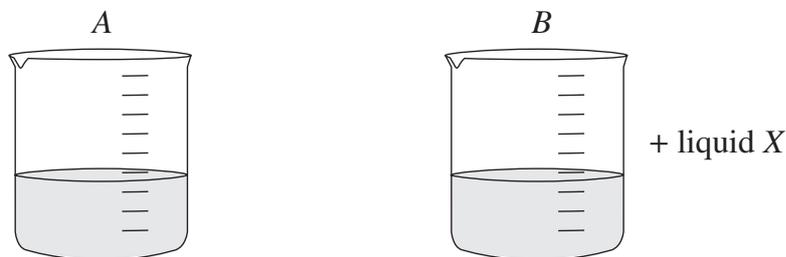
Outline ONE advantage and ONE disadvantage of transmitting music using digital technology, compared to the use of AM or FM radio waves.

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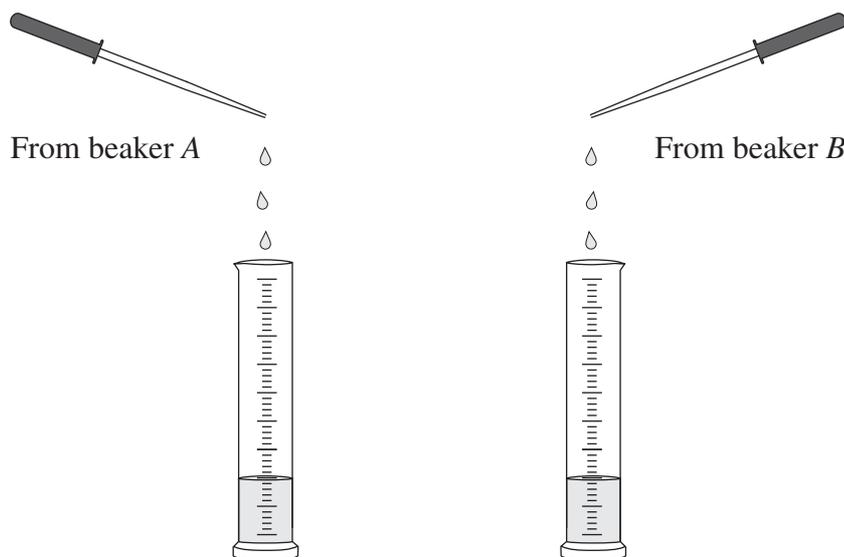
Question 23 (5 marks)

50 millilitres of pure water was poured into each of two clean beakers *A* and *B*.

Four drops of liquid *X* were dissolved in the water in beaker *B*.



Two identical clean, disposable droppers were used to transfer, drop-by-drop, two millilitres of liquid from each beaker into separate measuring cylinders. The number of drops of each liquid was counted. The experiment was conducted six times following the same procedure and the results were recorded.



Results

	<i>Trial</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
Number of drops for 2 mL from <i>A</i>	110	108	111	178	112	109
Number of drops for 2 mL from <i>B</i>	178	180	181	180	175	179

Question 23 continues on page 21

Do NOT write in this area.

Question 23 (continued)

- (a) Propose an explanation for the effect that liquid X had on the results. **2**

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- (b) Explain why the experiment needed to be repeated several times. Refer to the table of results in your answer. **3**

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End of Question 23

Question 24 (6 marks)

Analyse how the respiratory system and the circulatory system work together to maintain life in humans.

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Question 25 (4 marks)

- (a) Some components of a shampoo are listed: **1**

sodium laureth sulfate, cocamidopropyl betaine, acrylamide copolymer, ammonium chloride, methylchloroisothiazolinone, citric acid, titanium dioxide, disodium EDTA, sodium chloride, glycerin, sodium hydroxide, mica, zinc chloride.

Choose one of these components and outline why it is used in the shampoo.

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- (b) Explain the relationship between the natural pH of the skin and the pH of everyday products for skin and hair. **3**

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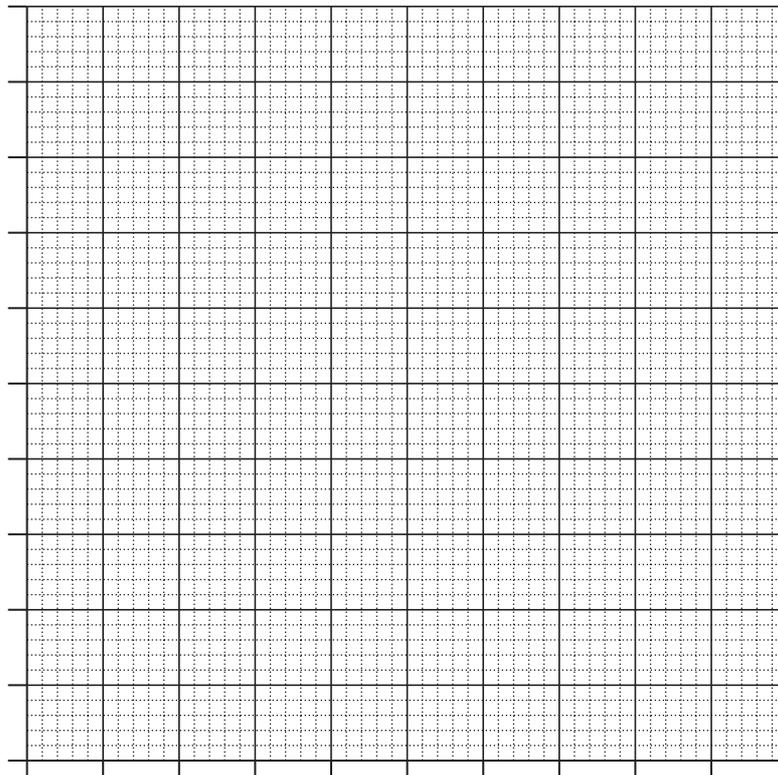
Question 26 (8 marks)

Students performed an investigation to test the hypothesis that exercise increases heartbeat rate.

- (a) Three students, *P*, *Q* and *R*, measured their heartbeat rate before and after 10 minutes of exercise on the same treadmill at the same speed. Student *P* registered 65 beats per minute (bpm) before exercise and 130 bpm after exercise. Student *Q* registered 70 bpm before exercise and 135 bpm after exercise. Student *R* registered 60 bpm before exercise and 120 bpm after exercise.

4

Construct an appropriate graph to display this data.



Do NOT write in this area.

Question 26 continues on page 25

Question 26 (continued)

(b) Other factors may influence the heartbeat rate of a person exercising on a treadmill.

(i) The students were testing the hypothesis that exercise increases heartbeat rate. **1**

Propose a different hypothesis related to the same activity on a treadmill.

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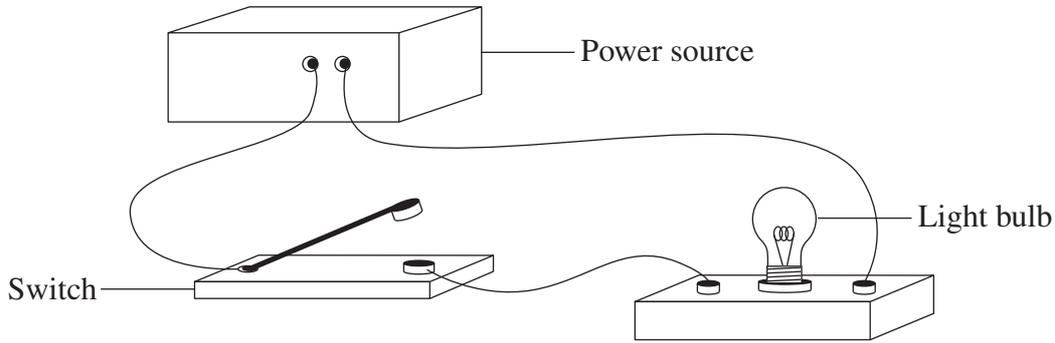
(ii) Justify TWO changes to the procedure the students used in part (a) that would be needed to validly test this new hypothesis. **3**

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End of Question 26

Question 27 (5 marks)

The diagram shows apparatus that can be used to code a message in Morse code.



- (a) In Morse code, the message consists of a series of dots (short flashes of light) and dashes (long flashes of light).

2

The table shows some letters in the alphabet in Morse code.

<i>Letter</i>	<i>Morse code</i>
A	Dot dash
B	Dash dot dot dot
D	Dash dot dot
I	Dot dot
M	Dash dash
T	Dash

Alice uses the apparatus to send the words BAT and DIM to Bob using Morse code.

What problem could Bob have in decoding these words and how could this be resolved?

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Question 27 continues on page 27

Question 27 (continued)

- (b) Describe how the scientific principle involved in the operation of optical fibres could be applied to the transmission of coded information from the light bulb in the apparatus. Use a labelled diagram in your response.

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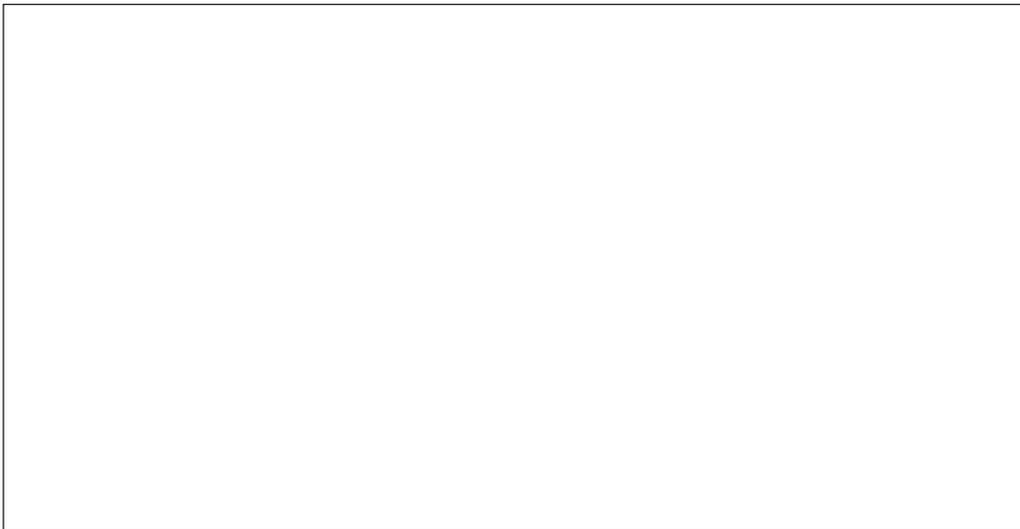
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End of Question 27

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Question 28 (6 marks)

Analyse the use of TWO artificial biomaterials in the replacement of damaged skeletal structures by completing the table.

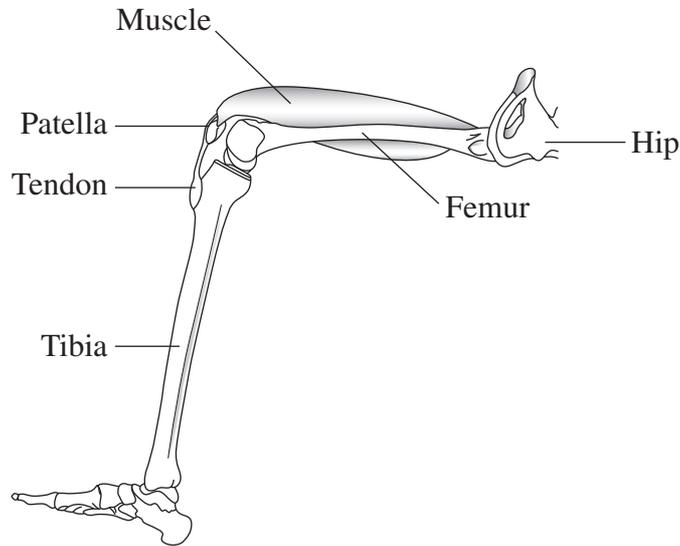
6

	<i>Biomaterial 1</i>	<i>Biomaterial 2</i>
Name
Properties
Replaced skeletal structure
Reasons for using this biomaterial

Do NOT write in this area.

Question 29 (5 marks)

The diagram shows parts of the body that make movement associated with the knee joint possible.



- (a) Outline how these components work together to cause the leg to straighten. **2**

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- (b) Describe the different types of leg movements that are made possible by the structure of the human hip joint. **3**

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Question 30 (6 marks)

A gold mine is established in a remote area 1000 km from the nearest fixed telephone line.

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Discuss the use of TWO different information systems in providing communication for the operation of the mine.

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Section I Part B extra writing space

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Senior Science

Section II

25 marks

Attempt ONE question from Questions 31–35

Allow about 45 minutes for this section

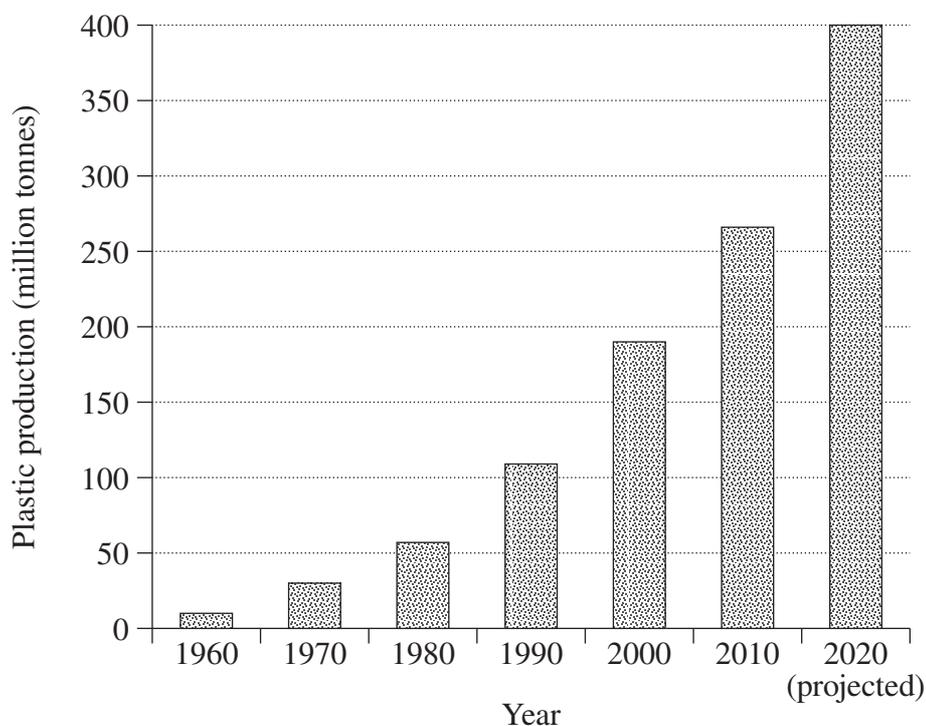
Answer parts (a)–(e) of one question in the Section II Writing Booklet. Extra writing booklets are available.

	Pages
Question 31 Polymers	34–35
Question 32 Preservatives and Additives	36
Question 33 Pharmaceuticals	37–38
Question 34 Disasters	39–40
Question 35 Space Science	41

Question 31 — Polymers (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

- (a) A first-hand investigation is to be conducted into the thermal properties of natural polymers.
- (i) Outline a potential hazard associated with this investigation and suggest a way the risk caused by the hazard could be reduced. **2**
 - (ii) Outline the steps necessary to carry out the investigation. **4**
- (b) The graph shows information about world production of plastic. **3**



Describe ONE environmental impact of the use of plastics. Refer to the graph in your answer.

- (c) Justify TWO reasons why it is desirable to recycle synthetic polymers. **4**

Question 31 continues on page 35

Question 31 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

- (d) (i) Copy and complete the following table in your answer booklet. **2**

<i>Example of a thermoplastic</i>	<i>Example of a thermoset plastic</i>

- (ii) Distinguish between *thermoplastics* and *thermoset plastics* in terms of their properties and use. **4**
- (e) Assess how the use of synthetic polymers has influenced society. In your answer, refer to specific properties of identified synthetic polymers. **6**

End of Question 31

Question 32 — Preservatives and Additives (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

- (a) An experiment is to be carried out to investigate how quickly different salts, used for the curing of meats, dissolve.
- (i) Outline a potential hazard associated with this experiment and suggest a way the risk caused by the hazard could be reduced. **2**
 - (ii) Outline the steps necessary to carry out the experiment. **4**
- (b) The diagram shows a label from a food product as required by government legislation. **3**

Ingredients Water, Sugars, Fibre E460 (3%), Amino acids, Fatty acids, Phytosterols, E515, E300, E306
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Discuss the usefulness to the consumer of food labelling. In your answer, refer to the label shown.

- (c) Analyse the relationship between a cause of food spoilage and preservation techniques used to prevent spoilage. **4**

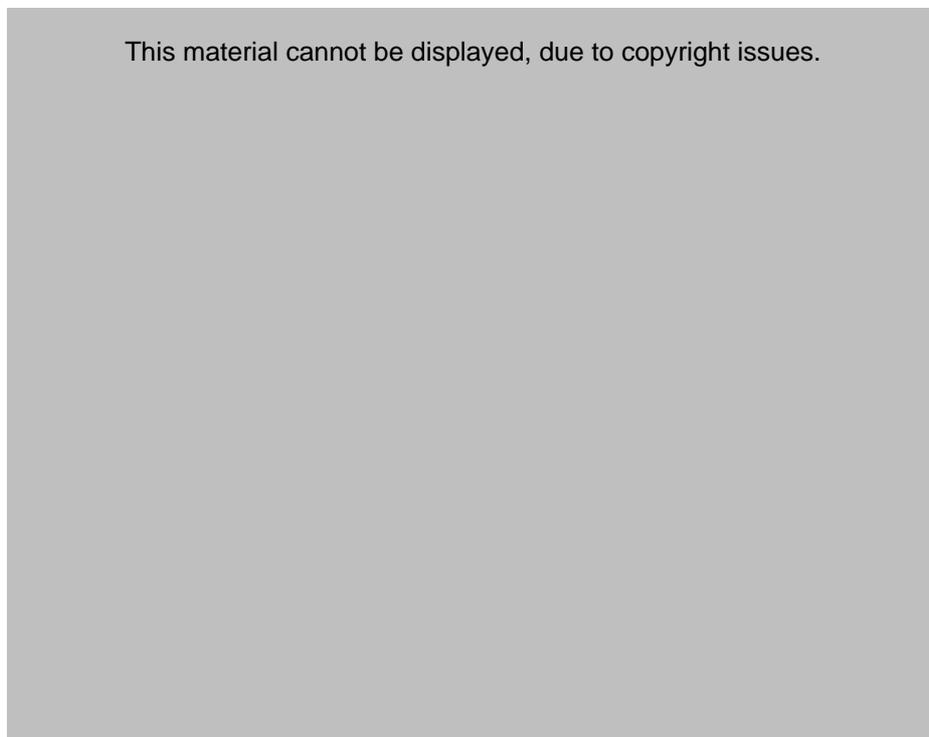
Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

- (d) (i) Identify TWO reasons for using additives that are NOT preservatives in food. **2**
- (ii) Explain ONE advantage and ONE disadvantage of using a specific additive other than a preservative in food. In your answer, name this additive. **4**
- (e) Assess impacts on society of food preservation techniques. **6**

Question 33 — Pharmaceuticals (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

- (a) An investigation is to be carried out to culture bacteria that were taken from surfaces in a hospital.
- (i) Outline a potential hazard associated with this investigation and suggest a way of reducing the risk caused by the hazard. **2**
 - (ii) Outline the steps necessary to carry out the investigation. **4**
- (b) The diagram shows some cells in the human body. **3**



Identify cell *X* and describe TWO roles of these cells in the human body.

- (c) Explain ONE advantage and ONE disadvantage of inflammation in the human body. **4**

Question 33 continues on page 38

Question 33 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

- (d) (i) Identify the chemical composition of aspirin and a group of pharmaceuticals to which it belongs. **2**
- (ii) Consider the two processes: **4**
- Process 1:* A reflex arc produces a response to a painful stimulus.
Process 2: A painful stimulus gives rise to a sensation of pain.
- Outline a similarity and a difference between the two processes.
- (e) Explain ways that antibiotics work and analyse the impacts of antibiotic use on society. **6**

End of Question 33

Question 34 — Disasters (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

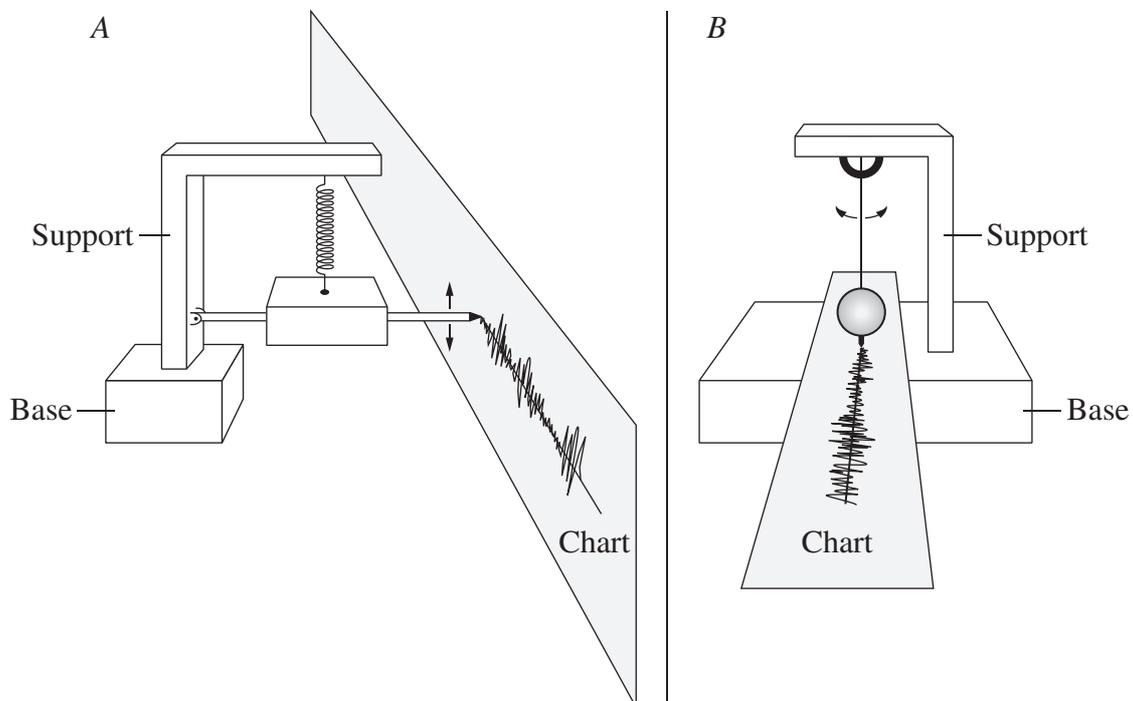
- (a) An investigation is to be carried out by students to compare the flammability of dried leaves from different types of trees.

Safety glasses, fireproof protective clothing and gloves are to be worn by the students to protect them from heat while carrying out the investigation.

- (i) Outline a potential hazard, other than heat, associated with this investigation and suggest a way the risk associated with this hazard could be reduced. **2**
- (ii) Outline the steps necessary to carry out the investigation. **4**

- (b) Identify TWO different types of fire extinguisher, and outline a specific use for each type of extinguisher. **3**

- (c) The diagrams show models for two different types of seismograph, *A* and *B*. **4**



Explain the limitations of each seismograph with reference to the measurement of *P*, *S* and *L* waves.

Question 34 continues on page 40

Question 34 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

- (d) (i) Outline how air movements lead to the formation of a tornado. **2**
- (ii) Describe how laser light can be used to obtain information about the atmosphere. In your answer, include examples of the specific types of information that can be obtained. **4**
- (e) Analyse the relationship between the monitoring of weather conditions and bushfire events. **6**

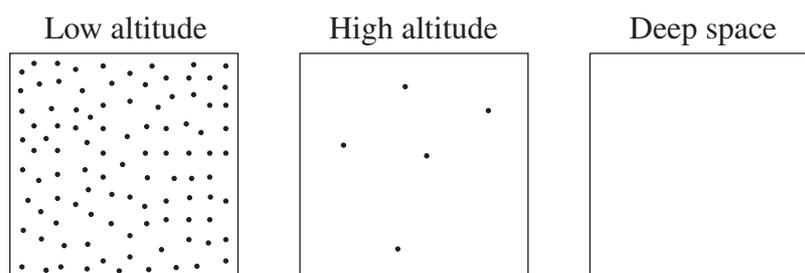
In your answer, refer to weather conditions both in the months and years preceding a major bushfire as well as the conditions at the time of the outbreak of the bushfire.

End of Question 34

Question 35 — Space Science (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

- (a) An investigation is to be carried out into the exercises an astronaut could perform in a spacecraft. 2
- (i) Outline a potential hazard associated with this investigation and suggest a way that the risk to the astronaut carrying out the exercises could be reduced. 2
- (ii) Justify TWO activities that could be done to exercise leg muscles on a six-month space journey. 4
- (b) A student has drawn diagrams to represent the relative concentration of gas particles at different altitudes. 3



Assess the accuracy of the student's diagrams.

- (c) Justify TWO requirements necessary for humans to survive during space travel to another planet in the solar system. 4

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

- (d) (i) Identify TWO limitations of using ground-based telescopes to collect information about our solar system. 2
- (ii) Explain how TWO limitations of using ground-based telescopes have been reduced or overcome. Use specific examples in your answer. 4
- (e) Assess contributions that past spacecraft have made to the design of subsequent space vehicles. 6

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