NSW GOVERNMENT

NSW Education Standards Authority

Centre Number

Student Number

2024 **HIGHER SCHOOL CERTIFICATE EXAMINATION**

Investigating Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- Write your Centre Number and Student Number at the top of this page

Total marks: 100

Section I – 20 marks (pages 2–13)

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

Section II – 80 marks (pages 17–40)

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this section

Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

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

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1 Which option shows developments in the history of flight in chronological order?

A. Kites, hot air balloons, Wright brothers' aeroplane, space flight

B. Hot air balloons, Wright brothers' aeroplane, space flight, kites

C. Hot air balloons, space flight, Wright brothers' aeroplane, kites

D. Kites, Wright brothers' aeroplane, hot air balloons, space flight

2 A study was conducted to determine how deep into the soil an oil spill can penetrate.

- A 50 g soil sample was placed in a 100 mL beaker.
- 50 mL of oil was poured on top of the soil sample.
- The depth the oil penetrated into the soil was measured after 10 minutes.

Which modification would NOT improve the data collected?

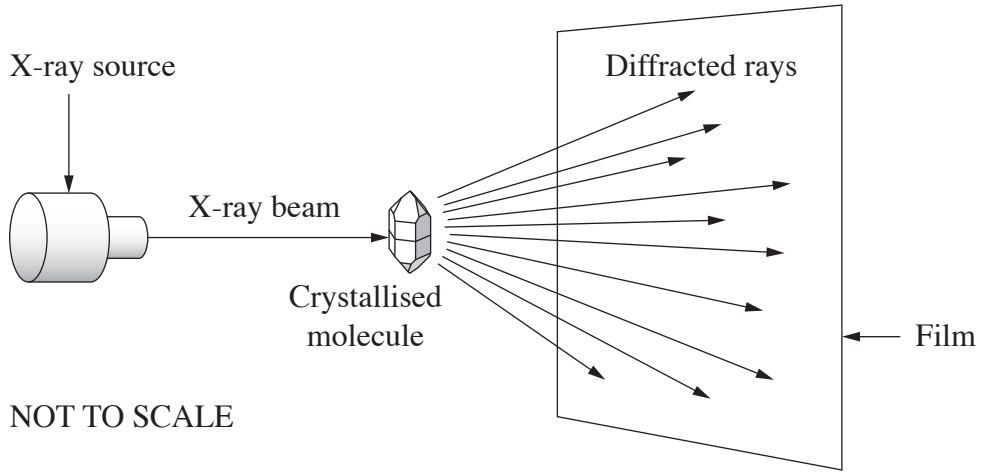
A. Using a 50 mL beaker

B. Testing different types of oil

C. Testing different types of soil

D. Using soil samples with varying levels of moisture

3 The technological apparatus shown played an important role in advancing our scientific understanding.



Which scientific advancement did this technology lead to?

A. Discovery of the Higgs boson

B. Development of atomic theory

C. Improved understanding of Earth's geological history

D. Discovery of the structure of deoxyribonucleic acid (DNA)

4 A skin care company is looking to employ a popular sports person to promote its new acne cream in television advertisements. This company has recently received negative reviews about some of its other products.

Which row in the table identifies the type of effect the company is utilising for the promotion and the reason for this strategy?

	Effect	*Reason for strategy*
A.	Halo	Consumers ignore negative reviews due to a positive association with the company.
B.	Halo	Consumers ignore negative reviews due to a positive association with the sports person.
C.	Hawthorne	Consumers ignore negative reviews due to a positive association with the company.
D.	Hawthorne	Consumers ignore negative reviews due to a positive association with the sports person.

5 Where is the most appropriate place for the abstract to be located in a scientific report?

A. Between the method and the results

B. After the title and before the method

C. Between the results and the conclusion

D. After the conclusion and before the references

6 The information shown relates to schedules for early childhood vaccinations.

Disease	*Age of vaccination(s)*
Hepatitis B	Birth
Whooping cough	2 months 4 months 6 months
Rotavirus	2 months 4 months
Pneumococcal	2 months 4 months
Influenza B	6 months+

Based on the data in the table, what is the maximum number of diseases a 5-month-old child should be fully vaccinated against?

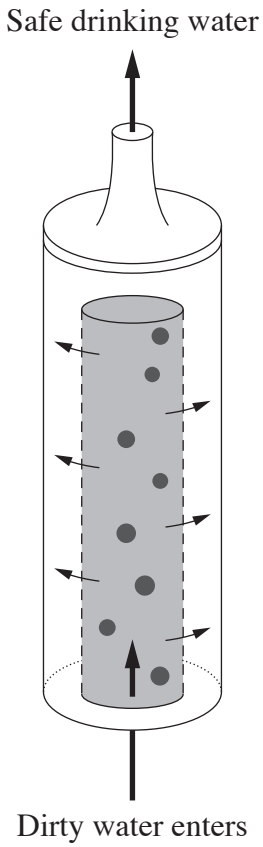
A. 1

B. 2

C. 3

D. 4

7 Scientific research has led to the development of small tubes with the appearance of straws that can be used to purify water.



What is the most likely method these devices use to create safe drinking water?

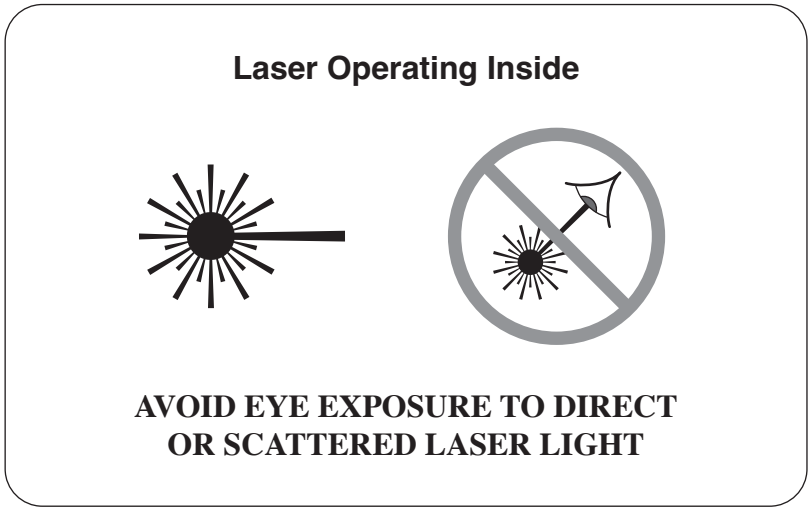
A. Chlorination

B. Desalination

C. Filtration

D. Flocculation

8 This sign was placed outside a room for the duration of an experiment.



What is the purpose of this sign?

A. To prevent the participants looking at the laser while it is operating

B. To provide a warning to the participants conducting the experiment

C. To prevent people from outside the room opening the door during the experiment

D. To provide a warning of a hazard located inside the room to people outside the room

9 Which of the following is NOT a benefit of the scientific peer review process?

A. Improved quality of research papers

B. Improved reporting of science in the media

C. Improved base of evidence for future research

D. Improved networking opportunities among research groups

10 This course covered a scientific study published in 1991 claiming a link between hormone replacement therapy and coronary heart disease.

Which factor related to the participants did this study NOT take into account?

A. Age

B. Gender

C. Socioeconomic status

D. Existing health conditions

11 What determines the reliability of an investigation?

A. Controlling all variables

B. Having a relevant control

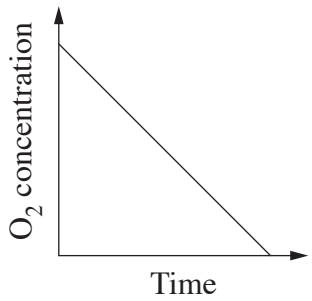
C. Repeating the experiment

D. Obtaining consistent results

12 A researcher set up an experiment involving a lighted candle inside a sealed jar. The concentration of oxygen gas was measured throughout the experiment.

Which graph best represents the expected results?

A.



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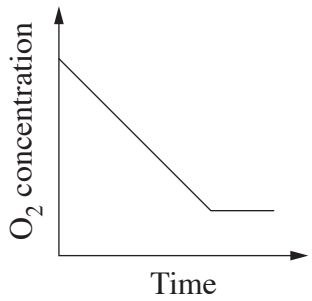
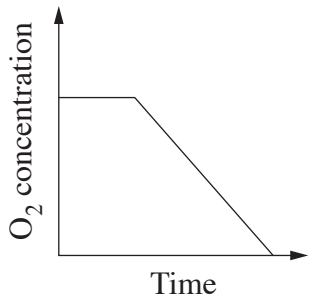
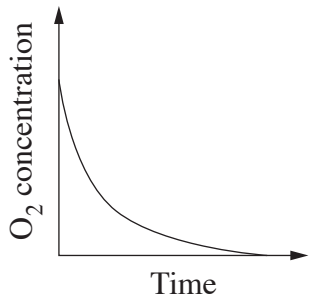


C.



D.



13 It was suspected that the regular blood pressure monitors used in a medical centre were not accurate. The blood pressure of three patients was measured using an accurately calibrated monitor. These were compared to three readings taken with the digital and analogue monitors from the centre.

Note: It is typical for each patient's blood pressure measurements to vary slightly between readings.

The readings are shown in the table.

Patient	*Blood pressure reading* (accurately calibrated monitor)	*Medical centre monitors*					
		Blood pressure readings (digital)			*Blood pressure readings* (analogue)		
1	149/90	134/85	135/84	134/85	150/90	151/90	150/90
2	168/96	149/92	151/91	150/90	167/97	168/98	167/96
3	145/89	130/82	130/81	130/83	145/88	146/87	146/88

Which row in the table identifies the more accurate blood pressure monitor normally used in the medical centre and the type of error present in the other monitor?

	More accurate monitor	*Type of error in less accurate monitor*
A.	Analogue	Systematic
B.	Digital	Systematic
C.	Analogue	Random
D.	Digital	Random

14 What impact did the prediction of the Higgs boson have on developments in technology?

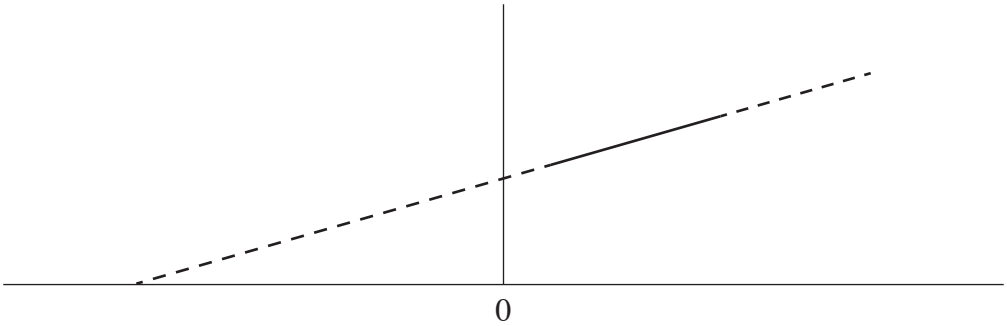
A. It resulted in the Large Hadron Collider.

B. It led to the discovery of the origin of mass.

C. It revealed the existence of subatomic particles.

D. It established the presence of a new form of matter.

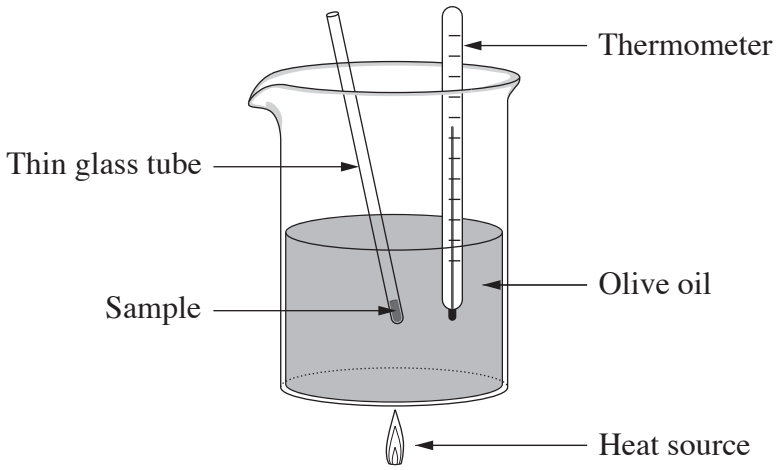
15 The graph shown was drawn by a student investigating gas samples.



Which row in the table shows the units that should be placed on each axis?

	Vertical axis	*Horizontal axis*
A.	L	K
B.	°C	L
C.	K	L
D.	L	°C

16 A student used the following procedure to test the claim that a substance had a melting point of 76.3°C.



1. A solid sample of the substance was placed in a thin glass tube.
2. The glass tube was placed in a beaker of olive oil (boiling point = 299°C) at room temperature.
3. A thermometer was placed in the olive oil.
4. The beaker was heated using a candle flame.
5. The sample was observed, and when it melted, the temperature of the olive oil was recorded.
6. The experiment was repeated twice. However, instead of using the candle to heat the beaker, a Bunsen burner and then a hot plate were used.

The results of the experiment are shown.

Heating method	*Temperature at which substance melted* (°C)
Candle	76
Bunsen burner	76
Hot plate	76

Which row in the table provides correct information about the validity and reliability of the student's procedure?

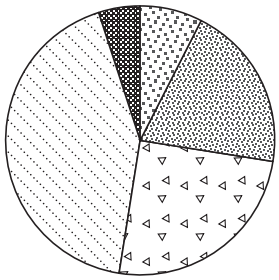
	Validity	*Reliability*
A.	Valid	Reliable
B.	Not valid	Reliable
C.	Not valid	Not reliable
D.	Valid	Not reliable

17 A survey was conducted to determine the most significant positive aspect of damming rivers. The results are shown in the table.

Positive aspect	*Tally*
Recreational use	3
Controlling flooding	8
Drinking and irrigation	17
Generating electricity	10
Other	2
Total surveyed	40

Which graph correctly depicts the data gathered by the survey?

A.



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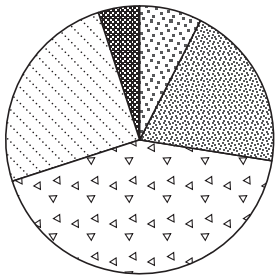

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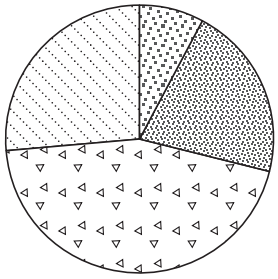

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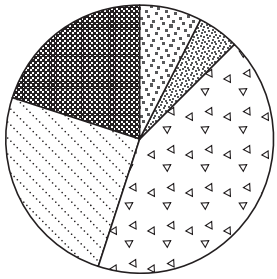


18 Highly-regarded science journals accept less than 10% of the papers presented for publication.

What is the final step required before a newly presented paper is to be published?

A. Peer review

B. Replication of the results

C. Validation of the investigation

D. Management of all the processes involved in an investigation

19 Consider the information in the table.

Research area	*Total jobs before research* ($\times 10^3$)	*Total jobs after research* ($\times 10^3$)	*Government investment in research* ($\times \$10^6$)	*Economic output due to government investment* ($\times \$10^9$)
Robotics	0.6	27.2	188.5	19.8
Nuclear power	1.5	8.5	584.0	4.5
Antimicrobial drugs	2.3	6.1	121.4	4.1
Genetically modified foods	6.8	23.6	442.1	12.5

Which area of research has provided the greatest economic return on government investment per job created?

A. Robotics

B. Nuclear power

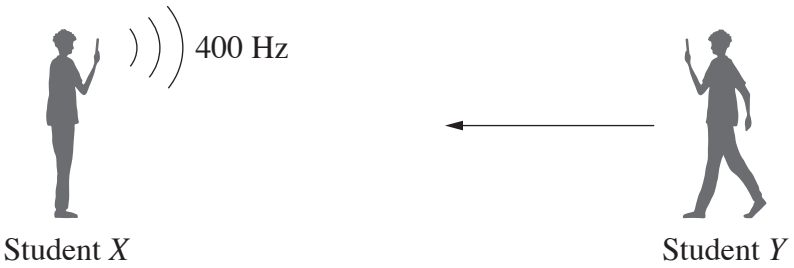
C. Antimicrobial drugs

D. Genetically modified foods

20 Two students conducted an investigation into the Doppler effect. In each experiment, Student *X* used their phone to produce a sound of 400 Hz while Student *Y* used their phone to record the sound produced.

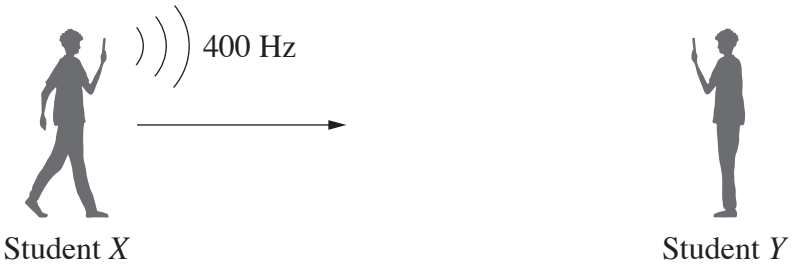
Experiment 1

Student *Y* walks toward Student *X*



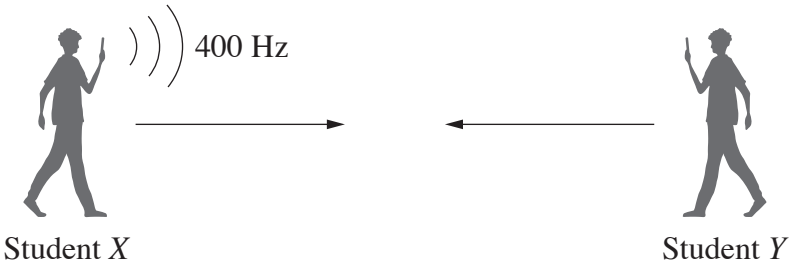
Experiment 2

Student *X* walks toward Student *Y*



Experiment 3

Both students walk toward each other



What would be the recorded frequency in each experiment?

	Recorded frequency (Hz)		
	Experiment 1	*Experiment 2*	*Experiment 3*
A.	400	400	> 400
B.	> 400	> 400	> 400
C.	> 400	> 400	400
D.	400	400	400

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2024 HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Student Number

Investigating Science

Section II Answer Booklet

80 marks
Attempt Questions 21–35
Allow about 2 hours and 25 minutes for this section

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.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

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Question 21 (3 marks)

Percy Spencer was involved in the development of an item of everyday technology used in many homes in Australia. **3**

Identify the technology AND outline the circumstances that led to its development.

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Question 22 (3 marks)

Explain the effect that early childhood vaccination programs have on world health. **3**

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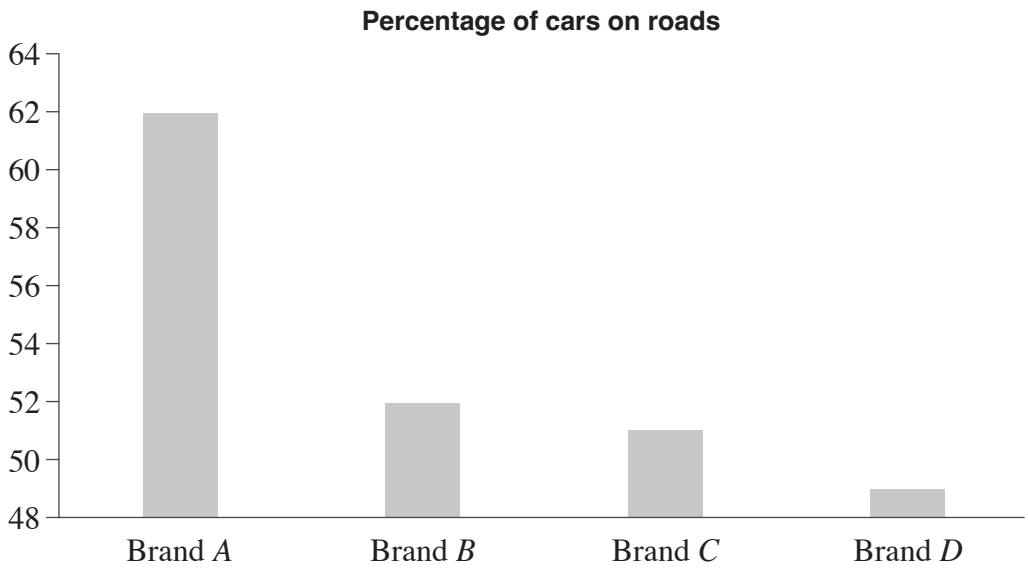
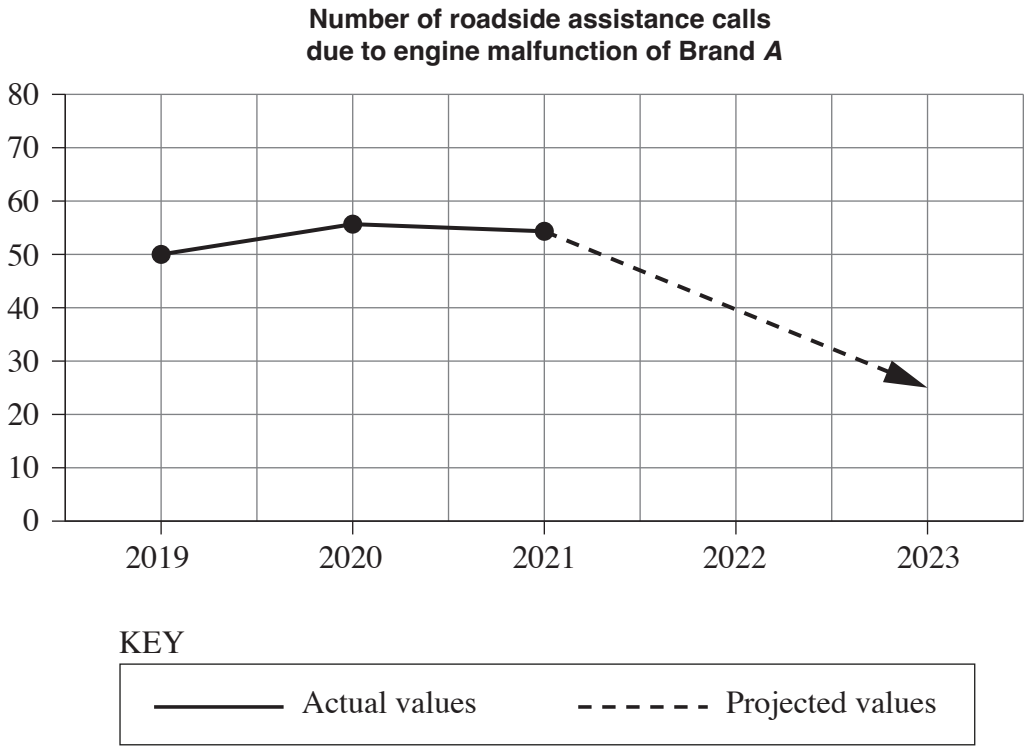
Question 23 (4 marks)

A company that makes a particular car, Brand *A*, was criticised for the low quality of its vehicles due to their increased risk of engine malfunction. To counter these criticisms, the company published an article early in 2024 that contained the graphs shown. **4**





Question 23 continues on page 21

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Question 23 (continued)

Analyse how the graphs have misrepresented data to enhance the public image of the company.

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Question 24 (3 marks)

Scientists are increasingly aware of the knowledge and understanding that Aboriginal and Torres Strait Islander Peoples have about the uses of native plants. **3**

Explain why this knowledge is valued by the scientific community. In your response, refer to a specific plant and its use.

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Question 25 (4 marks)

Evaluate the impact of ONE specific surgical device on human wellbeing. **4**

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Question 26 (4 marks)

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

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(b) Explain why numerology is considered to be a pseudo-science. **3**

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Question 27 (8 marks)

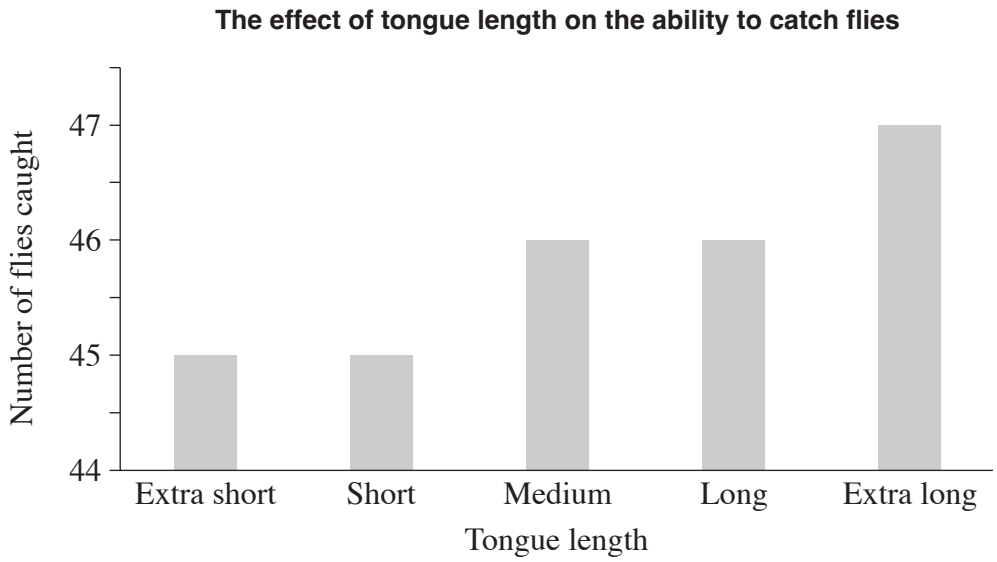
A student observed lizards catching flies in a forest and formulated the following inquiry question:

'*What impact does tongue length have on a lizard's ability to catch food?*'

The following investigation was conducted:

- Five lizards with varying tongue length were removed from their natural habitat.
- Each lizard was placed in a controlled environment for 30 minutes, one at a time.
- Each lizard was placed on the same branch and in the same position.
- 50 flies were then introduced into the controlled environment each time.
- The number of flies caught by each lizard was counted.

The data was collected and arranged in the graph shown.



Question 27 continues on page 25

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Question 27 (continued)

(a) Justify whether the student could ethically conduct this investigation. **2**

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(b) State the conclusion that the student should have drawn, based on the data collected. **2**

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(c) Justify THREE modifications to the methodology that would improve the integrity of this scientific investigation. **4**

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Question 28 (11 marks)

(a) Describe a sequence of steps that a student could use to validly and reliably determine the relationship between the pressure and volume of a sample of gas. **7**

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Question 28 continues on page 27

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Question 28 (continued)

(b) Justify a step in the investigation that ensures the results are valid. **2**

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(c) In the space provided, sketch a graph with appropriate axes that clearly demonstrates the relationship between the pressure and volume of the gas sample. **2**

End of Question 28

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Question 29 (4 marks)

Smallpox is the only human disease that has been totally eradicated. **4**

Explain the importance of the events that led to the development of a vaccine for 'the annihilation of the smallpox' (Edward Jenner, 1801).

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Question 30 (4 marks)

Two students made the following statements about the continuation of funding for space exploration. **4**

Student *A*: '*Space exploration holds the solutions to many of our current problems – it must continue to be funded*.'

Student *B*: '*We have not yet managed to overcome poverty or world hunger – let's spend our money on fixing the problems we already have*.'

Discuss the continuation of funding for space exploration. In your response, refer to each student's statement and your own knowledge.

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Question 31 (9 marks)

A group of students carried out an investigation to test van Helmont's conclusion about plant growth. One of the students wrote some details about their investigation.

> *The mass of our 6 seedlings was 2 grams, 3 grams and 3.5 grams in the first group and 2.5 grams, 2 grams and 3 grams in the second group. We planted them in soil in separate pots and gave the first group 5 millilitres of water every day and the second group 10 millilitres of water every day, for 4 weeks.*
>
> *We removed, washed and weighed the plants. They now had masses of 3.5 grams, 4 grams and 4.5 grams in the first group and in the second group 5 grams, 4.5 grams and 5.5 grams.*
>
> *We then calculated the changes in mass.*

(a) State a relevant hypothesis for the students' investigation based on the information provided. **1**

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(b) The data from this investigation was collected using a balance that weighed accurately to the nearest 0.5 grams. **3**

Construct a table in the space provided. Arrange ALL the data in a clear and logical manner.

Question 31 continues on page 31

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Question 31 (continued)

(c) Compare the students' investigation results with those of van Helmont. **2**

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(d) Evaluate the validity of the investigation performed by the students to test van Helmont's conclusion. **3**

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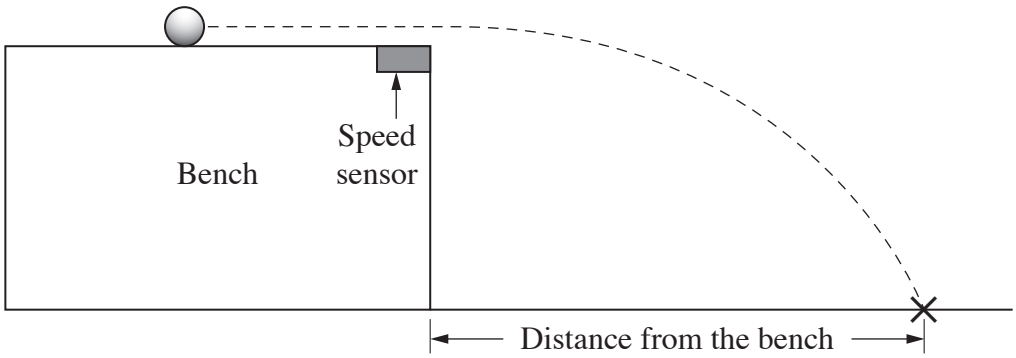
Question 32 (6 marks)

A student investigated the relationship between distance and speed by rolling a ball off a level benchtop at different speeds and measuring the distance the ball travelled before landing on the floor. A speed sensor was used to accurately measure the speed of the ball as it left the benchtop.



The results of the investigation are shown.

Speed (m s^{-1})	*Distance* (m)
1.10	0.50
0.85	0.38
0.54	0.24
0.77	0.15
0.31	0.14
0.46	0.21

Question 32 continues on page 33

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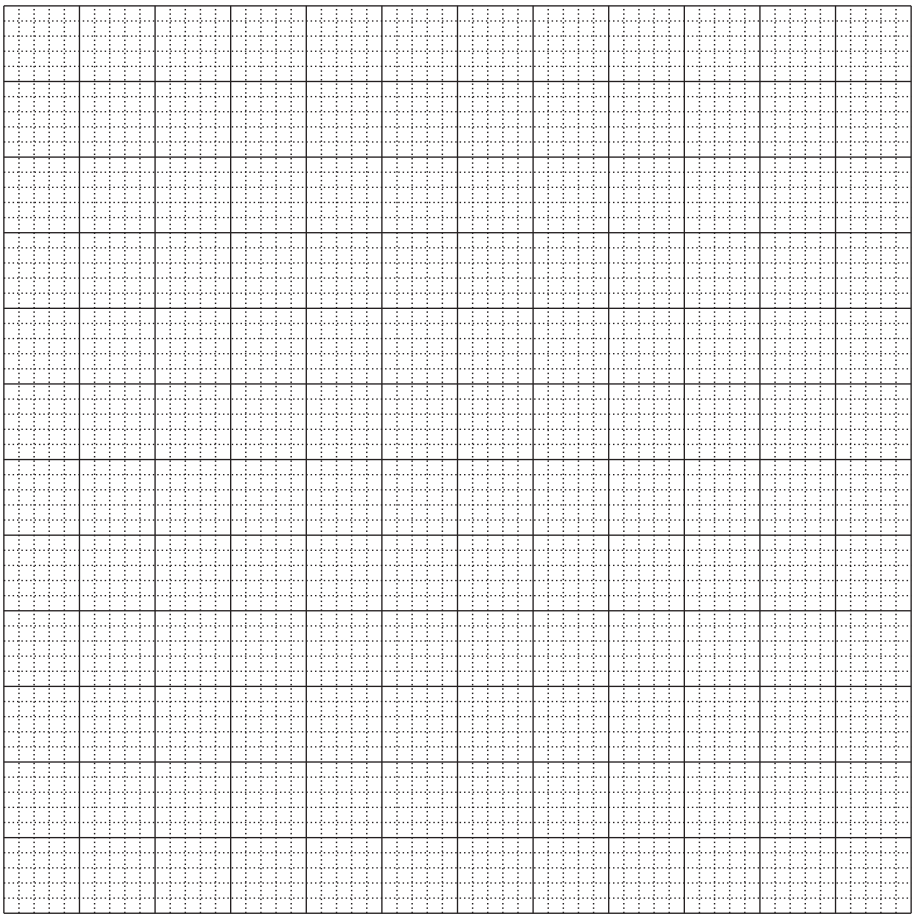
Question 32 (continued)

(a) Graph these results including an appropriate line of best fit. **3**



(b) What does the gradient of the graph represent? Support your answer with a calculation of the gradient. **3**

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Question 33 (5 marks)

Bread is consumed daily by billions of people. Evidence regarding the effects of the type of bread on glycaemic control (control of blood sugar levels) is unclear.

A scientific study was published in a peer reviewed journal, as outlined.

- A randomised trial lasting two weeks was conducted with two groups of 10 individuals.
- Each group consumed either wholegrain bread or white bread.
- At the end of two weeks, no significant difference in glycaemic control was found between the two groups.
- Some individuals in both groups were found to have better glycaemic control than other participants.
- The authors acknowledged that eating wholegrains is known to be beneficial for health and that this study would have to be repeated for a longer duration.
- It was suggested that glycaemic control might be based solely on gut bacteria and not the type of bread consumed.
- The authors of this paper declared a conflict of interest as they were paid as scientific consultants for a company that markets personalised gut bacteria products and nutrition.

(a) Describe an issue related to the methodology of this study. **2**

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Question 33 continues on page 35

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Question 33 (continued)

(b) Explain the possible effect that the declared conflict of interest may have had on the study. **3**

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End of Question 33

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Question 34 (5 marks)

Analyse the impact that governments can have on university research project budgets. In your answer, refer to a specific example. **5**

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Question 35 (7 marks)

Some scientific research supports the use of copper bracelets to ease the pain of stiff and sore joints caused by arthritis. **7**

Justify the use of placebos, double-blind trials and control groups in an investigation to test the effectiveness of wearing copper bracelets to ease pain caused by arthritis.

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