

NSW Education Standards Authority

2022 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

Total marks: 100

Section I – 20 marks (pages 2–11)

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

Section II – 80 marks (pages 13–32)

- Attempt Questions 21–33
- 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.

- 1 Which scientist(s) collected data to investigate peptic ulcers?
 - A. Doppler
 - B. Smolyanitsky
 - C. Marshall and Warren
 - D. Pons and Fleischmann
- 2 Which event is most likely to have improved the public image of science?
 - A. A decrease in biodiversity after the damming of a river
 - B. The reduction in transport times due to the development of flight
 - C. High levels of radiation in the environment due to a nuclear meltdown
 - D. Unexpected negative side effects after administration of a smallpox vaccine
- 3 What gas did Priestley collect data on?
 - A. Hydrogen
 - B. Oxygen
 - C. Radon
 - D. Xenon

Use the information provided to answer Questions 4–5.

A student designed an investigation to test their hypothesis that plants lose more water on a windy day than on a non-windy day.

- 1. The student had two pot plants of the same size and the same type of plant.
- 2. Both pots were weighed, then one pot was placed outside in the wind, while the other was left inside.
- 3. After six hours, the outside pot plant was brought inside and both pot plants were weighed.
- 4 Which row in the table correctly identifies the independent variable and a controlled variable in this investigation?

	Independent	Controlled
A.	Wind	Water loss
B.	Water loss	Size of pot
C.	Wind	Type of plant
D.	Water loss	Wind

- 5 Which of the following statements about this investigation is correct?
 - A. It does not have a control.
 - B. It has no dependent variable.
 - C. It is well designed because it tests reliability.
 - D. It is poorly designed because not all variables are controlled.
- 6 What was the scientific advancement made possible by the interpretation of the photograph taken by Rosalind Franklin in 1952 using X-ray diffraction?
 - A. Evidence of the structure of the DNA molecule
 - B. Understanding the pathway of X-rays through DNA
 - C. The pattern of radiation given off by a DNA molecule
 - D. Understanding the reflection and refraction of X-rays through DNA

A parent purchases a music book for their child who is learning to play an instrument. They choose a more expensive book that has the picture of a popular recording artist on the cover rather than a similar book with a plain cover.

What does the perception behind this purchase illustrate?

- A. The halo effect
- B. The Mozart effect
- C. The butterfly effect
- D. The accordion effect
- **8** Which of the following would be an example of ethical scientific practice?
 - A. Selectively removing outliers from results prior to peer review
 - B. Stopping an expensive medical trial due to negative side effects
 - C. Declaring a conflict of interest between the conclusion of a scientific trial and the publishing of results
 - D. Ensuring consent of participants is obtained between the conclusion of a scientific trial and the publishing of results

Use the following information to answer Questions 9–10.

A company claims that its dietary supplement reduces cholesterol by 10% after one week of use. The company measured the cholesterol level of eight people who had been taking the supplement for one week and compared the measurements to the cholesterol level of eight people who had not taken the supplement.

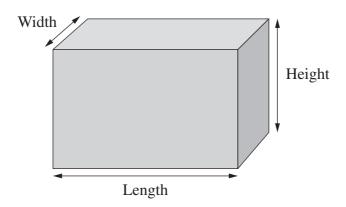
The company presented the data in the table to support their claim.

AVERAGE BLOOD CHOLESTEROL LEVEL (mmol L ⁻¹)					
Group with supplement	Group without supplement				
5.2	5.8				

- **9** What is the dependent variable in this experiment?
 - A. Diet
 - B. The supplement
 - C. Blood cholesterol level
 - D. The number of people in each group
- 10 Why could the claim made by the company be considered misleading?
 - A. There is no control group in the experiment.
 - B. The reduction in cholesterol levels according to the averages provided is $0.6 \text{ mmol } L^{-1}$.
 - C. The people taking the supplement may have been unknowingly influenced by the Hawthorne effect.
 - D. The initial blood cholesterol levels of the participants in each group were not taken into consideration.

- 11 The purpose of a placebo in a scientific investigation is to
 - A. act as a control.
 - B. increase the number of participants.
 - C. ensure no bias is demonstrated by researchers.
 - D. compare the effectiveness to previous medication used.
- 12 The volume of a box is given by the formula:

Volume = Length \times Width \times Height.



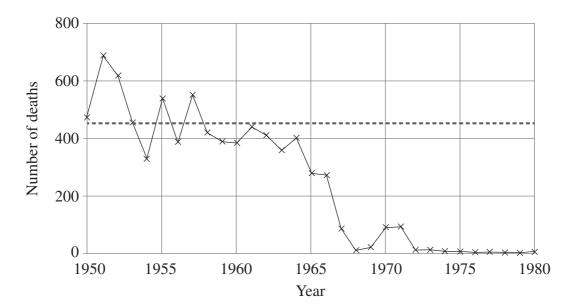
A student measured the dimensions of a box and recorded them.

Dimension	Length (m)
Length	2.86
Width	0.91
Height	2.00

Which of the following should the student use to report the volume of the box?

- A. 5 m^3
- B. 5.2 m^3
- C. 5.21 m^3
- D. 5.2052 m³

13 The graph shows the number of deaths due to an infectious disease. The 10-year average number of deaths was calculated for the period 1952–1961 and is shown as a dotted line across the entire graph.



A student hypothesised that a vaccine was introduced against the infectious disease some time between 1962 and 1968.

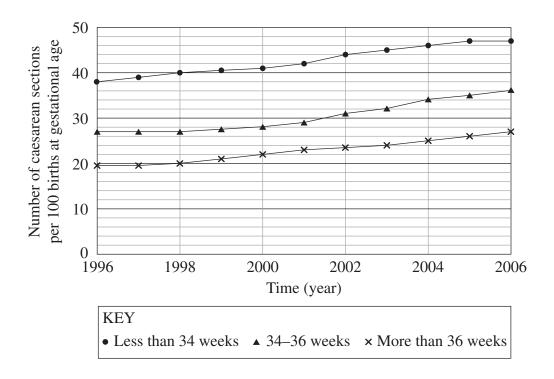
How does data from the graph support this hypothesis?

- A. There were zero deaths from the disease after 1968.
- B. There were fewer cases of the disease in 1968 than in 1970.
- C. The number of people contracting the disease decreased between 1962 and 1968.
- D. The number of people dying from the disease was consistently below the 10-year average after 1968.
- A researcher wants to determine the efficacy of a new medication intended to treat a condition by conducting a double-blind trial on a group of people who suffer from the condition. The group of people involved in the trial are randomly assigned to be in Group *A* or Group *B*.

How should this trial be conducted?

- A. The researcher allocates a placebo to Group A and the medication to Group B.
- B. The researcher allocates a placebo AND the medication to Group *A* and allocates a placebo AND the medication to Group *B*.
- C. Placebos are allocated to Group A and the medication is allocated to Group B, without the researcher knowing what allocations have been made.
- D. Placebos AND the medication are allocated to Group *A* and placebos AND the medication are allocated to Group *B*, without the researcher knowing what allocations have been made.

15 The graph shows a country's rate of birth by caesarean section (surgical removal) according to gestational age between 1996 and 2006. Gestational age is the time a baby has been inside the uterus before it is born.



Which statement about the graph is correct?

- A. There were 25 caesarean births in 2004 for babies with a gestational age of more than 36 weeks.
- B. 40% of babies with a gestational age of less than 34 weeks were born by caesarean section in 1998.
- C. The rate of caesarean births in the 34–36 weeks gestational age range increased uniformly over the time period shown.
- D. Babies with a gestational age of more than 36 weeks had an increased rate of caesarean birth compared to babies born with less than 34 weeks gestation.
- A student wants to conduct an experiment to determine the relationship between the speed of a car and the distance that it travels.

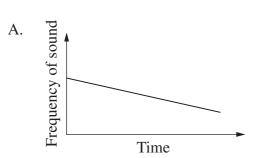
Which variable should be kept constant during the experiment?

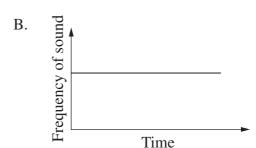
- A. The model of the car used
- B. The distance travelled by the car
- C. The speed at which the car travels
- D. The period of time that the car travels

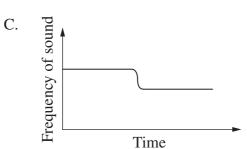
17 A vehicle travelling at constant speed also produces sound of constant frequency.

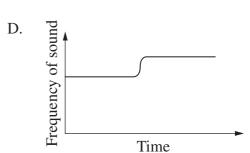
A stationary student used a data logger to graph the frequency of the sound over a period of five seconds: as the vehicle approached, passed and then continued to move away from the student.

Which graph best represents the data collected?









A student wanted to calculate the average speed of a motorised toy car over 5.00 metres. The student conducted four trials, recording the time taken for the car to cover 5.00 metres. The student entered the results in the table as shown.

Trial	Time (s)
1	12.1
2	1.20
3	12.2
4	12.0

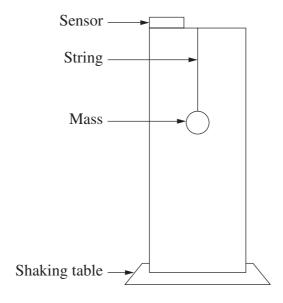
What is the best approximation for the average speed of the toy car?

- A. 0.413 m s^{-1}
- B. 0.533 m s^{-1}
- C. 1.65 m s^{-1}
- D. 2.13 m s^{-1}

Use the information provided to answer Questions 19–20.

A tuned mass damper (TMD) is a piece of technology that can be used to reduce the damage to buildings during an earthquake. A TMD is a large mass that is suspended from the top of a building.

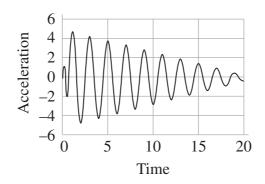
A student wanted to investigate the effect of a TMD by constructing the model shown in the diagram.



The model had the following features:

- 1. A shaking table that moves horizontally at a constant frequency to model the forces a building would experience during an earthquake.
- 2. A sensor placed at the top of the model to record horizontal acceleration.

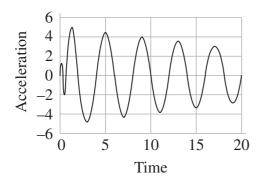
With no mass suspended from the top of the model, the student recorded the results shown in the graph.



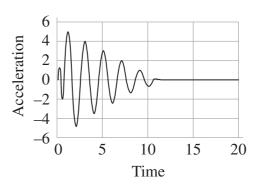
19 The student then repeated the experiment with a large mass suspended from the top of the model.

What would be the expected shape of the graph produced after this change?

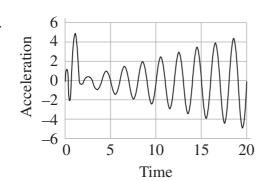
A.



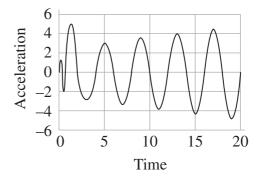
В.



C.



D.



- 20 Which is the best explanation for the effectiveness of a TMD, according to Newton's laws?
 - A. Increasing the mass of the TMD decreases the inertia of the building.
 - B. The TMD will reduce the magnitude of the equal but opposite forces on the building.
 - C. As the acceleration of the building increases, the horizontal force on the TMD decreases.
 - D. The acceleration of the building is inversely proportional to the combined mass of the TMD and building.

BLANK PAGE

2022 HIGHER SCHOOL CERTIFICATE EXAMINATION						
			Ce	ntre	Nun	nber
Investigating Science						
			Qtu.c	lont	Nlun	hor

80 marks
Attempt Questions 21–33
Allow about 2 hours and 25 minutes for this section

Section II Answer Booklet

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.

Please turn over

BLANK PAGE

Question 21 (3 marks)

Complete the table to identify TWO different sections of a student's investigative report AND the purpose of each section.

Section of investigative report	Purpose of this section

Please turn over

Question 22 (6 marks)

A group of students wanted to compare the accuracy of two types of balance. A sample of iron with a known mass of 1.15 kg was weighed three times on each balance. The results are shown in the table.

MASS OF IRON (kg)				
Analogue balance	Digital balance			
1.12	1.30			
1.12	1.27			
1.16	1.29			

(a)	Using data from the table, assess the accuracy of the analogue balance and the digital balance.	3
(b)	A student suspected the difference between the known value and the experimental results could be due to random error.	3
	Justify the steps a student could take to minimise random error in this investigation.	

Question 23 (4 marks)

example to support your answer.

Please turn over

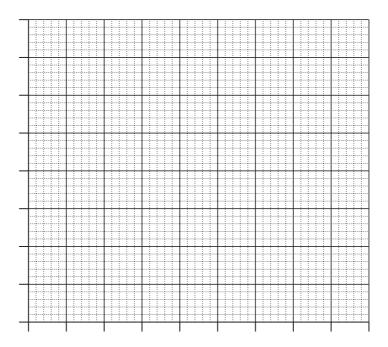
4

Question 24 (9 marks)

A student carried out an investigation to test the claim that the average mass of a sugar cube is 4.0 g. The student used a balance to measure the mass of multiple sugar cubes. The results are shown in the table.

Number of sugar cubes	Recorded mass (g)
5	10
10	30
15	50
20	70
25	104
30	110
35	130
40	136

(a) Graph these results on the grid provided AND include an appropriate line of best fit for the data.



Question 24 continues on page 19

Ques	tion 24 (continued)
(b)	Propose reasons for TWO significant features of the line of best fit you have drawn for the data.

3

(c) Using your graph, determine the average mass of one sugar cube.

2

End of Question 24

Question 25 (5 marks)
Justify the method used by Eratosthenes to calculate the circumference of Earth.

Question 26 (4 marks)

Some Indigenous communities have formed benefit-sharing partnerships with scientists, governments and large corporations.
Analyse the impacts of ONE benefit-sharing partnership involving an Indigenous community. Use a specific example of a benefit-sharing partnership in your response.

Please turn over

Question 27 (4 marks)

Explain the method that van Helmont used to investigate how plants grow. In your answer, refer to variables that van Helmont controlled.

Question 28 (7 marks)

Analyse how economic influences have impacted the collection and manipulation of statistical data. Include a relevant example in your response.						

Question 29 (7 marks)

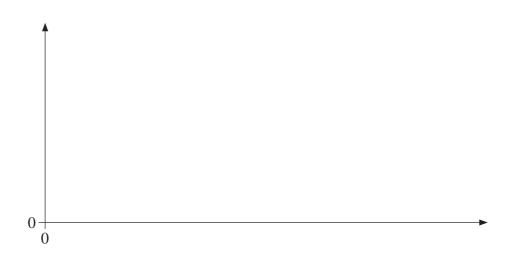
A student carried out an experiment to investigate the relationship between the temperature and the volume of a gas sample.

(a) Describe a series of steps for this experiment that would allow a student to safely and reliably collect first-hand data.

5

••••	• • • • •	• • • • •	••••	• • • •	• • • • •	• • • •	• • • • •	••••	••••	••••	• • • • •	••••	• • • •	• • • •	• • • •	• • • •	••••	••••	••••	• • • •	• • • • •	••••	••••	• • • •	• • • •	• • • •	• • • • •	• • • •	••••
••••	• • • • •	• • • • •	••••	• • • •	• • • • •	• • • •	• • • • •	• • • •	••••	••••		••••	• • • •	• • • •	• • • •	• • • •	••••	••••	••••	• • • •	• • • • •	••••	••••	• • • • •	••••	• • • •	• • • • •	• • • •	••••
••••	• • • • •	• • • • •	••••	• • • •	• • • • •	• • • •	• • • • •	• • • •	••••	••••		••••	• • • •	• • • •	• • • •	• • • •	••••	••••	••••	• • • •	• • • • •	••••	••••	• • • • •	••••	• • • •	• • • • •	• • • •	••••

(b) Sketch the expected results for this experiment AND add appropriate labels (including units) on the axes.



Question 30 (4 marks)

Higgs boson. Refer to the Large Hadron Collider (LHC) in your response.

Please turn over

Question 31 (4 marks)

The direction of scientific research has changed in areas such as:

- perceptions about diet in a multicultural society
- investigating traditional medical treatments
- mining practices.

Evaluate how different perspectives can influence the direction of scientific research. In your answer, refer to an example above OR to a specific example of scientific research you have studied.

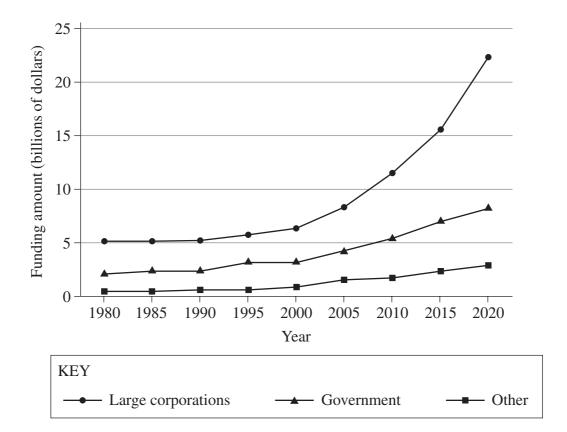
Question 32 (6 marks)
Discuss the value of peer review in relation to the advancement of science.

Please turn over

3

Question 33 (17 marks)

The graph shows how the funding sources for scientific research for a particular country have changed over time.



(a)	Describe the trends in the graph.

Question 33 continues on page 29

Question 33 (continued)

(b)	If the trends in the graph were to continue, justify the need to regulate funding from large corporations for scientific research.	4
(c)	A large corporation provides funding for research into a new water purification tablet.	
	(i) Explain the impact that this research could have on world health.	3

Question 33 continues on page 30

7

Question 33 (continued)

(ii)	Before funding the research into the water purification tablet, the large corporation requires the researchers to enter into a contract with the following conditions:
	1. the corporation will only fund the research for three years
	2. the funding is only sufficient to test the safety of the tablet on 100 people.
	Evaluate how these contract requirements could influence the integrity of the investigation.

End of paper

Do NOT
⊣ ≶
vrite
<u></u>
this
<u>a</u>
rea.