Student Name

Student Number

Sydney Secondary College Blackwattle Bay

2023

Trial Higher School Certificate Examination

Investigating Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw using a pencil
- Write your student number at the top of every page
- Write your name in the space provided
- Calculators approved by NESA may be used
- Answer sheet for multiple-choice Section I is provided

Total Marks - /100

Section I Pages 2-12
Total Marks (20)
Attempt Questions 1-20
Allow about 40 minutes for this section

Section II Pages 14-28
Total Marks (80)
Attempt ALL Questions 21-35
Allow about 2 hour 20 minutes for this section

This paper MUST NOT be removed from the examination room

Student Name

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Section I
20 marks

Attempt Questions 1–20
Allow about 40 minutes for this part

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

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1 Observations can result in inferences, and these often lead to the formation of scientific theories.

Which of the following best described the inference made by Von Helmont that lead to his theory about plant growth?

A. His willow tree gained mass because he was adding water.

B. His willow tree gained mass because of the nutrients in the soil.

C. His willow tree gained mass because he was adding water and fertiliser.

D. His willow tree gained mass because it was allowed to grow a long time.

2 Greek mathematician and geographer, Eratothenes, was able to determine the circumference of the Earth to a high level of accuracy, despite having access to only the most basic of equipment. He did this through collecting both primary and second-hand data.

Which of the following correctly identifies the second-hand data used by Eratosthenes?

A. The distance between Syene and Alexandria.

B. The time difference between Syene and Alexandria.

C. The height of shadows cast at noon during the summer solstice in Alexandria.

D. The angles of shadows cast at noon in Alexandria during the summer solstice.

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3 The Safe Work Australia Act 2008 requires all laboratories to use the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) to classify and label chemicals by types of hazard.

The symbol below represents one type of hazard.



If the symbol appeared on a chemical label, which type of hazard is being referred to?

A. Low level toxicity

B. Corrosive chemicals

C. Hazardous to aquatic life and the environment

D. Fatal or toxic if swallowed, inhaled or in contact with skin

4 A medicine, chemical or procedure that has no therapeutic effect and is often used in medical treatments and other experiments that have human subjects.

This is known as a

A. control.

B. placebo.

C. double-blind.

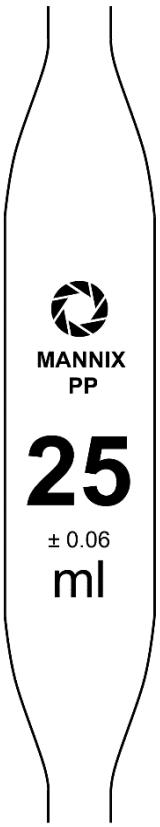
D. pseudoscience.

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5 A pipette is a commonly used laboratory tool that is considered to be an accurate way to transport a measured volume of liquid. The body of a pipette features markings that can be used to determine its accuracy.

A student fills the pipette shown in the diagram below.



Which of the following volumes may represent the actual volume held in the pipette?

A. 24.40 mL

B. 24.96 mL

C. 25.08 mL

D. 25.73 mL

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6 In the late 18th century, Edward Jenner made an important discovery, although once published, it would take almost two hundred years before his ideas were accepted by the scientific community, and members of the public had issues with his methodology.

Edward Jenner is best known for his

A. development of a smallpox vaccine.

B. manipulation of genes in biotechnology.

C. development of biotechnological weaponry.

D genetic modification of sex cells and embryos.

7 Students wish to look at the growth rate of different seedlings when they are provided with different amounts of water. They visit their local nursery and purchase the first seedlings that they see after entering.

What is this an example of?

A. Sample bias

B. Qualitative sampling

C. Convenience sampling

D. Voluntary response sampling

8 A scientist who is about to submit research for peer review is asked to double check that they have specified any measures that they have taken to reduce error.

Which of the measures below would help to reduce error in the scientist's research?

A. Including all results data in a graph to increase their research's validity.

B. Using the correct number of significant figures when recording results data.

C. Consulting prior research from an investigation carried out ten years earlier.

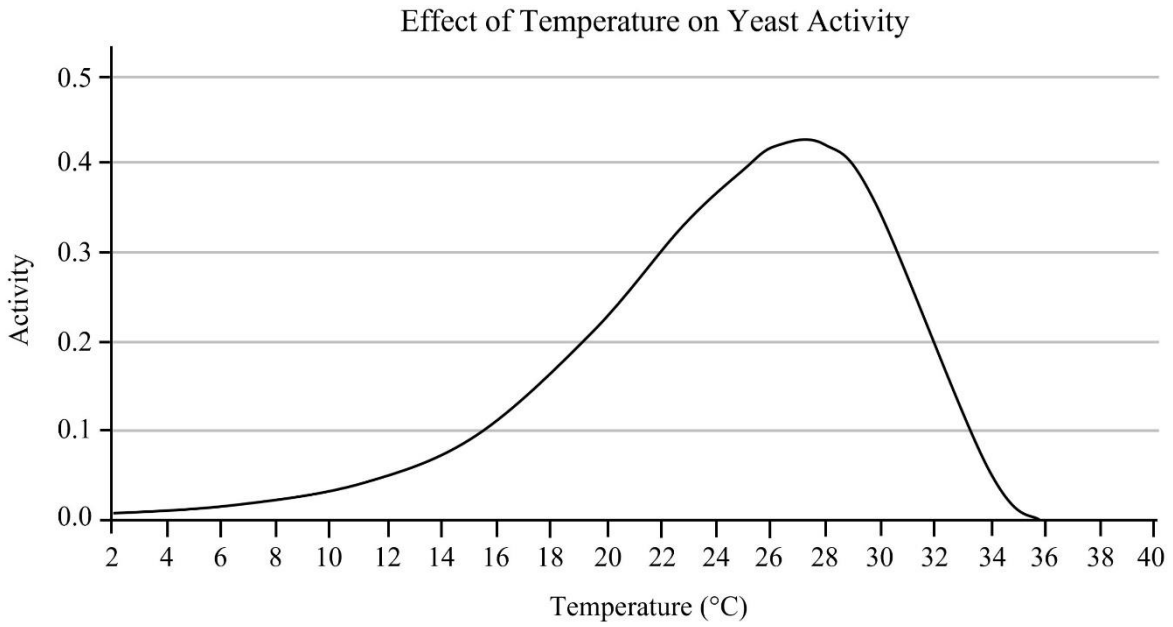
D. Maximining efficiency by having multiple assistants help with data collection.

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9 Fermentation is a process where glucose is broken down to ethanol and carbon dioxide by the action of enzymes present in yeast.

When used in baking, the carbon dioxide bubbles generated by the reaction are responsible for allowing the bread to rise. The rate of this reaction is dependent on temperature and is shown in the graph below.



Based on the graph, what would the optimum temperature for fermentation to take place be closest to?

A. 24°C

B. 25°C

C. 27°C

D. 29°C

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10 In 1984, Barry Marshall and Robin Warren determined that peptic ulcers were caused by a specific type of bacteria named *Helicobacter pylori* and not through life habits.

They collected primary data through experimentation, growing tissues cultures from biopsies before and after antibiotic treatment.

A justification for this type of data collection is that examining tissue cultures

A. was the safest way to conduct this type of experiment with live bacteria colonies.

B. could minimise the amount of time which was needed to complete the investigation.

C. could be used to find a link between the bacterium and the presence of peptic ulcers.

D. was the only way to collect evidence and show the presence of the bacterium in patients.

11 A researcher hypothesised that a new type of pet food would increase the muscle mass of dogs. The following experiment was designed to test this hypothesis.

- 200 dogs were included in the study of which 100 received the new dog food and 100 dogs received the older version of the food.
- An additional substance X, was added to ALL the dogs' water to help support nutrient absorption.
- The dogs were subjected to the same exercise regime.
- The muscle mass of the dogs were recorded after 2 weeks.

The researcher concluded that the new food increased the muscle mass of the dogs but not the overall body mass.

Why is this experiment invalid?

A. Only one type of dog was included in the stuy.

B. There is one dependent variable.

C. The number of dogs was too small to read a valid conclusion.

D. The effect of substance X on muscle mass was not tested.

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12 Indigenous cultural and intellectual property includes artwork, folklore, vital medicinal plants, animal and minerals, literature, design, knowledge and performing arts. Regulations are in place to ensure that the traditional landowners maintain control over their land and its resources.

The legislation document explaining these regulations is known as the:

A. Lands Acquisition Act 1989.

B. Regional Forest Agreements Act 2002.

C. Land Rights (Northern Territory) Act 1976.

D. Natural Heritage Trust of Australia Act 1997.

13 In 1989, Stanley Pons and Martin Fleischmann claimed to have replicated the nuclear fusion that takes place in the Sun in a normal laboratory. The pair made several decisions that ultimately lead to the idea of 'cold fusion' being retired to the fringes of science.

What could Pons and Fleischmann have done at the time to help their research be accepted by the scientific community?

A. Work independently to ensure that their idea was not copied and changed by others.

B. Prevent confusion by avoiding other possible theories that may explain their results.

C. Announce their results as soon as possible to ensure they get credit for the discovery.

D. Provide other scientists with their methodology so the experiment could be replicated.

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14 Numerology is a study of how numbers can influence the events in your life. It focuses on the idea that the universe is a system and, once it is broken down into its simplest parts, all that is left are numbers.

The calculation below shows how one of these numbers, the life path number, is calculated.

17th March 1944

17 = 1 + 7 = **8**

3 = **3**

1944 = 1 + 9 + 4 + 4
= 18
= 1 + 8
= **9**

8 + 3 + 9 = 20
2 + 0 = 2

What is the life path number for a person born on 14 July 1991?

A. 2

B. 3

C. 4

D. 5

15 As early as the 1950s, there was scientific evidence that linked smoking to lung cancer. This included research conducted by the cigarette industry which showed that cigarettes contained carcinogens which are chemical that can cause cancer. Rather than adapt or change their business model, cigarette companies embarked on a campaign of denial and misinformation.

Which of the following statements best describes the situation described above?

A. There is a conflict of interest as the cigarette company employed their own scientists.

B. There is confirmation bias as the scientists were trying to validate their own prior beliefs.

C. There is evidence of the Hawthorne effect where correlation can be misinterpreted as causation.

D. There is a strong likelihood of the scientific information being misinterpreted by the popular media.

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16 The Australian Code for The Care and Use of Animals for Scientific Purposes is a document that outlines the ethics involved in using animals in scientific investigations.

It states that, "respect for animals must underpin all decisions and actions involving the care and use of animals for scientific purposes" and that, "respect can be achieved through using animals only when it is justified, supporting the wellbeing of the animals involved, avoiding or minimising harm, including pain and distress, to those animals, and applying high standards of scientific integrity."

With regards to this statement, which of the following would not be an example of applying a high standard of scientific integrity?

A. Accurately recording all results data so that the findings can be easily reviewed

B. Minimising numbers of animal specimens required in any investigation undertaken

C. Checking if previous scientific research eliminates the need for further investigation

D. Carrying out additional testing once the investigation is complete to ensure validity

17 Which of the following statements is a positive impact of damming in Australia?

A. People living in the way of a dam and its lake may need to move causing families and communities to fragment.

B. The dam may flood farmland or natural landscape, drowning plants and animals that fail to adapt to lake conditions.

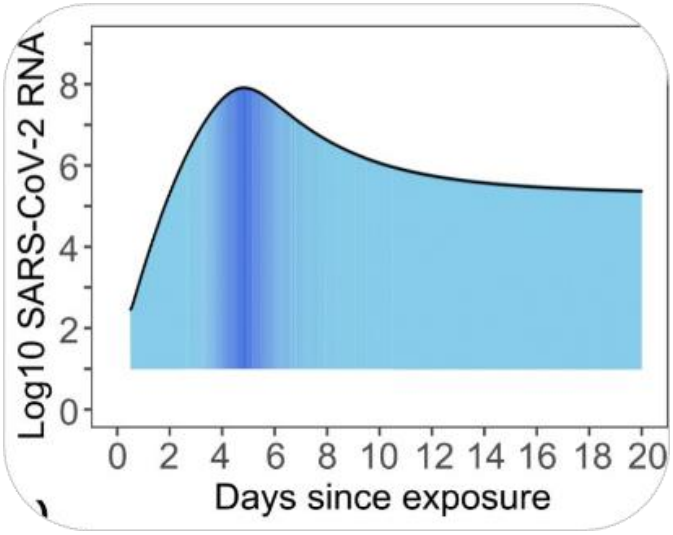
C. Dams can provide water and electricity, mitigate floods, and create beautiful lakes.

D. Species introduced into the reservoir for recreational fishing may alter the biological make-up of water life.

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18 Patients who are infected by COVID-19 are most infectious when their viral load is the highest.



For the patient above, on which day following exposure were they most infectious?

A. 2 days

B. 5 days

C. 8 days

D. 16 days

19 The particle accelerators that make up the Hadron collider are designed to make particles collide into each other after they have been fired in opposite directions at 99.9999991% the speed of light. In 2012, they were used to confirm the existence of the Higgs boson.

Which of the statements below refutes the idea that the Hadron collider has had a positive impact on the accumulation of evidence for scientific theories, laws and models?

A. The technology developed for the collider could have more useful applications in other branches of science.

B. Developments in the collider have led to improved safety for those working in areas where there may be radiation.

C. Comments have been made that the energy produced by the collider may have unpredictable and unforeseen effects.

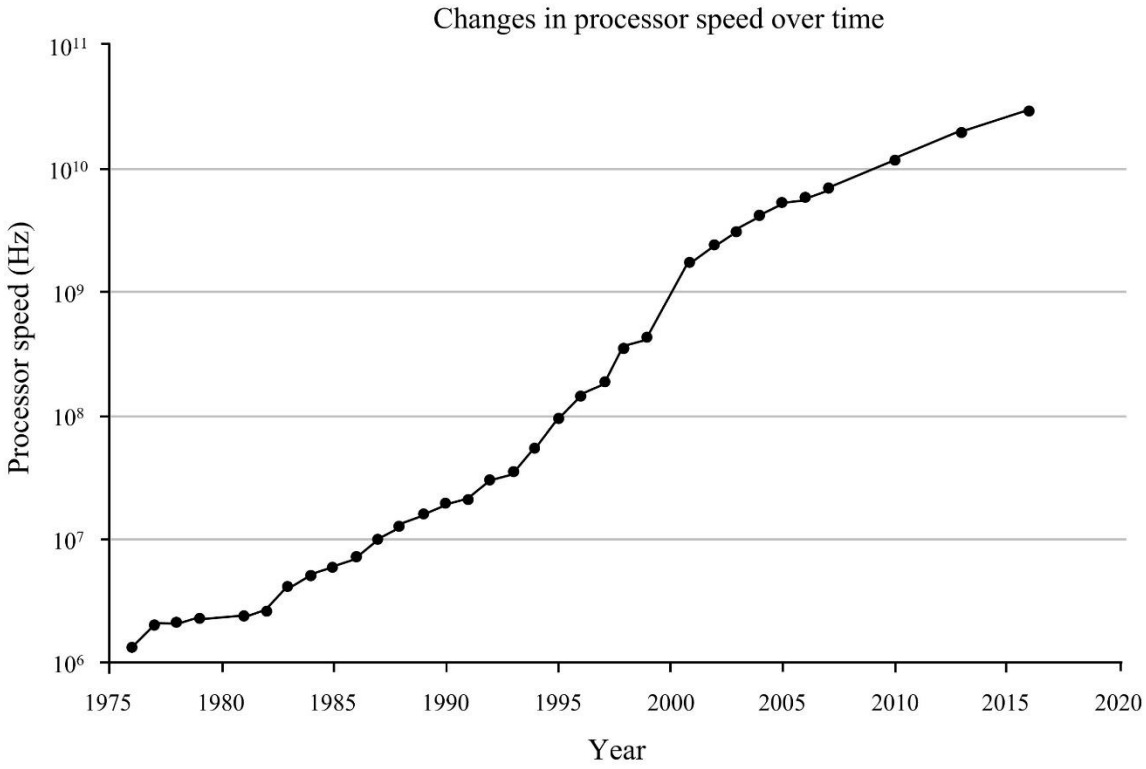
D. The collider allows collection of knowledge about systems that are unable to be observed physically due to size and time scale.

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20 A processor is the circuitry that responds to and processes the basic instructions that drive a computer. The faster the processing speeds, the more effective and responsive the computer.

The graph below shows how average computer processor speeds have increased over time.



In what year was the average processor speed closest to 100 000 000 Hz?

A. 1987

B. 1995

C. Comments have been made that the energy produced by the collider may have unpredictable and unforeseen effects.

D. The collider allows collection of knowledge about systems that are unable to be observed physically due to size and time scale.

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Investigating Science

Section II
Answer Booklet

80 marks
Attempt Questions 21–35
Allow about 2 hours 20 minutes for this section

Instructions

- Write your Name 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

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Question 21 (3 marks)

The image below shows a section of the Safety Data Sheet document for hydrochloric acid.

2. Hazard Identification

GHS classification of the substance/mixture	Skin Corrosion/Irritation: Category 1B Specific Target Organ Toxicity Single Exposure Category 3 (respiratory tract irritation) Corrosive to Metals: Category 1
Signal Word (s)	DANGER
Hazard Statement (s)	H290 May be corrosive to metals. H314 Causes severe skin burns and eye damage. H335 May cause respiratory irritation.
Pictogram (s)	Corrosion, Exclamation mark
	
Precautionary statement – Prevention	P234 Keep only in original container. P260 Do not breathe dust/fume/gas/mist/vapours/spray. P264 Wash skin thoroughly after handling. P271 Use only outdoors or in a well-ventilated area. P280 Wear protective gloves/protective clothing/eye protection/face protection.
Precautionary statement – Response	P301+P330+P331 IF SWALLOWED: rinse mouth. Do NOT induce vomiting. P303+P361+P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P304+P340 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

(a) Identify ONE hazard associated with the use of hydrochloric acid. **1**

(b) Suggest an appropriate safety strategy that could be implemented when using hydrochloric acid, and state how this would minimise any risk. **2**

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Question 22 (6 marks)

In 1946, Percy Spencer determined that microwaves could be used to cook food.

(a) Describe the factors that led to Spencer's investigations into microwaves. **2**

(b) State Spencer's hypothesis. **1**

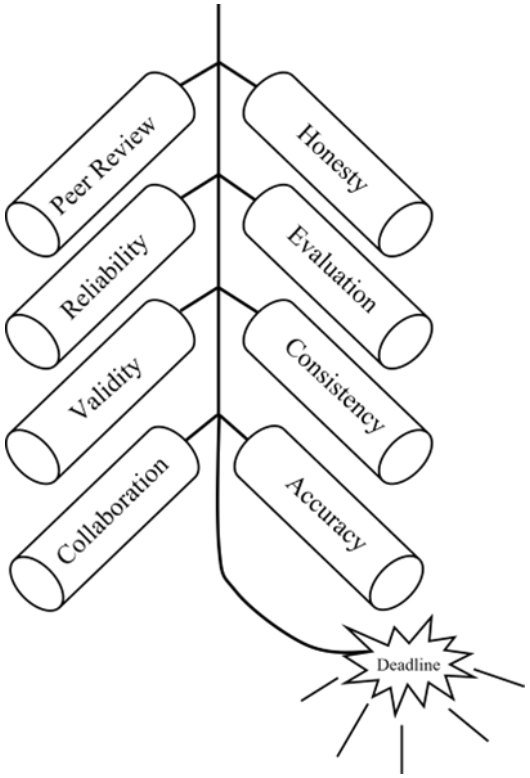
(c) Explain why it was necessary for Spencer to deviate from the traditional and linear models of scientific methodology in order to test his hypothesis. **3**

Student Name

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Question 23 (4 marks)

The cartoon below can be used to describe the effect of the phenomenon known as "publish or perish".



(a) State what is meant by the phrase, *publish or perish*. **1**

(b) With reference to the cartoon above, discuss the implication that the *publish or perish* phenomenon has on the scientific community. **3**

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Question 24 (6 marks)

For many generations, Aboriginal and Torres Strait Islander Peoples have used many different plant materials to treat illness and injury. Scientists are just beginning to discover how these treatments work with the aim of developing some into mainstream medicines.

(a) Identify ONE plant commonly used by Aboriginal and Torres Strait Islander Peoples for medicinal purposes, and state what it was used for. **2**

(b) State what is meant by the term *bioharvesting*. **1**

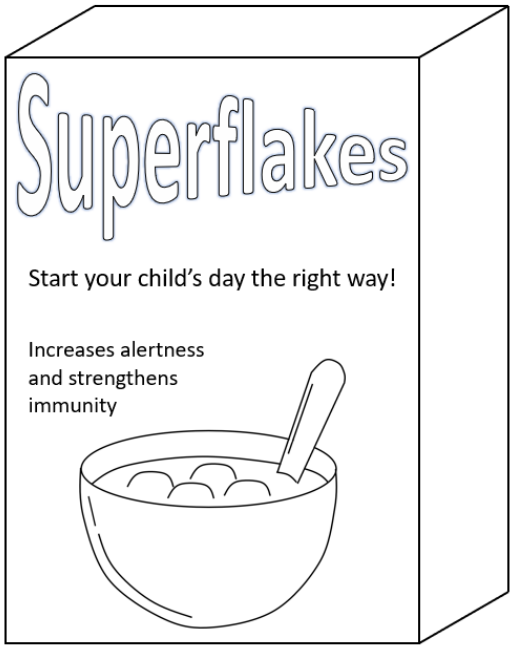
(c) Discuss possible ethical issues that may arise due to bioharvesting. **3**

Student Name

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Question 25 (4 marks)

A manufacturer has developed a new brand of cereal and has approved the packaging design shown in the diagram below.



(a) Identify the difference between *emotive advertising* and *evidence-based claims*. **2**

(b) Describe how ONE of the claims made by the cereal manufacturer could be considered emotional advertising. **2**

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Question 26 (6 marks)

Joseph Priestley was a British philosopher and chemist who is credited with the discovery of oxygen.

(a) Describe one of Priestley's investigations into the gas that would come to be known as oxygen. **2**

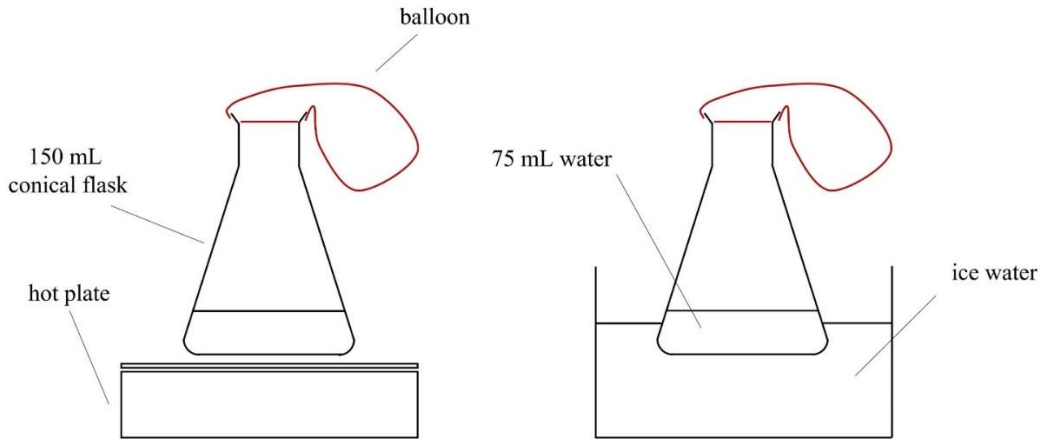
(b) Assess the methodology used by Priestley in his investigation. **4**

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Question 27 (6 marks)

A pair of students design and carry out an investigation to determine the effect of temperature on volume of gas. To do this, they set up the following apparatus:



One of the students suggests they should have used a digital thermometer to measure the temperature of the water. The other disagrees, stating that doing so would increase the chance of systematic errors.

(a) Identify what is meant by the term *systematic error* and describe an example that involves the use of a thermometer. **3**

(b) Compare the accuracy of analogue and digital thermometers. **3**

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Question 28 (7 marks)

A student plans an investigation to determine which types of fruits contain the highest percentage of water. Their procedure and equipment list can be seen below.

Procedure

1. Use the knife to cut a 2 cm cube of apple.
2. Place the cube on a watch glass.
3. Measure the mass of the cube.
4. Place watch glass in an oven set to 80°C.
5. Leave for 48 hours.
6. Measure the mass of the cube.
7. Determine percentage of water.
8. Repeat with the pear, banana and orange.

Equipment list

- apple
- pear
- banana
- orange
- oven
- watch glass x 4
- knife
- ruler
- chopping board
- digital balance

(a) Identify the independent and dependent variables in this investigation, and state TWO variables that should be controlled. **3**

(b) Justify the suitability of the materials used based on their relevance to the research question, availability, cost and risk. **4**

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Question 29 (8 marks)

The saying "correlation does not imply causation" is commonly used in the scientific community.

(a) State the difference between *correlation* and *causation*. **2**

(b) In 1924, researchers conducted an investigation at the Hawthorne Works electric facility in Chicago that led to the development of an idea that we now call the Hawthorne effect. **3**

Outline the investigation that led to this discovery.

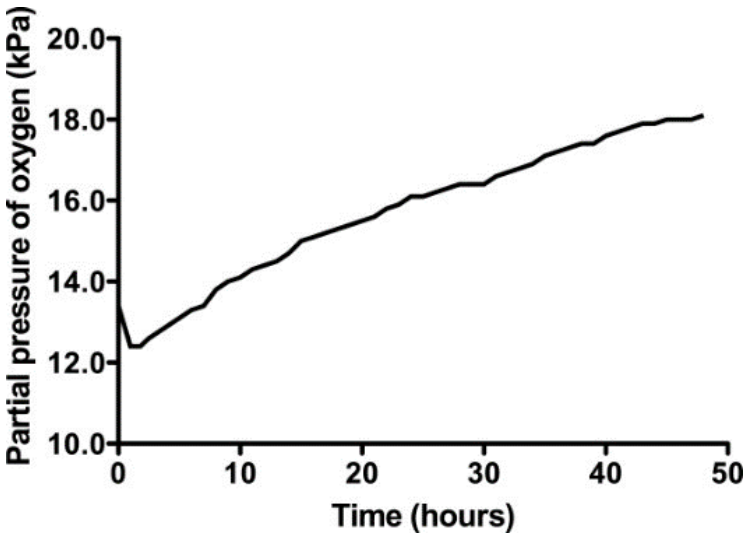
(c) Explain how this investigation demonstrates how evidence of a correlation can be misinterpreted as causation. **3**

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Question 30 (6 marks)

In 2012, Martin et al. recreated Priestley's bell jar experiments using a human subject and a modern-day bell jar. A single male subject was placed within a sealed, oxygen-depleted enclosure with 274 plants for a total of 48 hours. A combination of natural and artificial light was used to ensure continuous photosynthesis during the experiment. The results of the experiment are included in the graph below. There was no ethical approval received for this investigation.



(a) Describe the trends in the graph. **3**

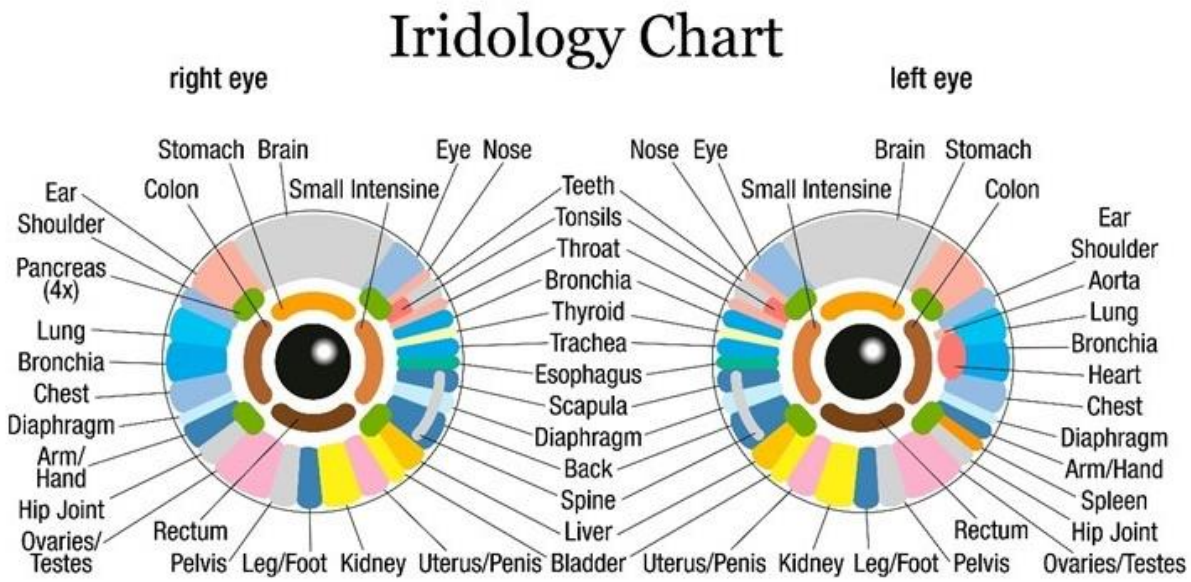
(b) Describe how the experiment deviated from the traditional and linear models of scientific methodology. **3**

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Question 31 (4 marks)

Iridology is an alternative medicine technique where patterns, colours and other characteristics of the iris are examined to determine information about a patient's health.



Explain how scientific language and processes can be manipulated to sway public opinion about the effectiveness of iridology. **4**

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Question 32 (4 marks)

Taipei 101 is a supertall skyscraper in Taipei, Taiwan. The building has 101 floors and reaches a height of 508.2 metres. Because Taiwan is prone to earthquake activity, several design features had to be incorporated into its design to ensure that it would be able to withstand any seismic activity. **4**



Describe a technology that could be incorporated into a building's design to make it more earthquake resistant and provide a link between this technology and one of Newton's laws of motion.

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Question 33 (4 marks)

Air travel is commonplace in modern society and is, in some ways, essential for the development of society. It enables face-to-face meetings between people who may be geographically distant and allows for the transport of people, animals, luggage and cargo within and between countries in a relatively short amount of time. **4**

With reference to a particular event, discuss how the development of flight has affected the public image of science.

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Question 34 (4 marks)

Explain the difference between a placebo group and a control group in a scientific investigation. **4**

Student Name

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Question 35 (8 marks)

Assess the impact that developments in scientific theories, laws and models have had on the development of a named technology. **5**

3

(b) Describe how one technology has had a significant impact on the discovery of the structure of deoxyribonucleic acid (DNA)

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Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Student Name

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If you use this space, clearly indicate which question you are answering.

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Investigating Science Trial 2023 Examination

Section I Answer Sheet

20 marks
Attempt Questions 1–20
Allow about 40 minutes for this section

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

1	A ○	B ○	C ○	D ○
2	A ○	B ○	C ○	D ○
3	A ○	B ○	C ○	D ○
4	A ○	B ○	C ○	D ○
5	A ○	B ○	C ○	D ○
6	A ○	B ○	C ○	D ○
7	A ○	B ○	C ○	D ○
8	A ○	B ○	C ○	D ○
9	A ○	B ○	C ○	D ○
10	A ○	B ○	C ○	D ○
11	A ○	B ○	C ○	D ○
12	A ○	B ○	C ○	D ○
13	A ○	B ○	C ○	D ○
14	A ○	B ○	C ○	D ○
15	A ○	B ○	C ○	D ○
16	A ○	B ○	C ○	D ○
17	A ○	B ○	C ○	D ○
18	A ○	B ○	C ○	D ○
19	A ○	B ○	C ○	D ○
20	A ○	B ○	C ○	D ○

2023 Investigating Science Trial Examination BWB Marking Guidelines

Section I

Multiple-choice Answer Key (Explanations on following page)

Question	Answer
1	A
2	A
3	A
4	B
5	B
6	A
7	C
8	B
9	C
10	C
11	D
12	C
13	C
14	D
15	A
16	D
17	C
18	B
19	C
20	B

Explanation of Multiple Choice Answers

Question	Answer	Explanation
1	A	Von Helmont believed that the willow tree only grew larger due to the fact that he had been watering it. He failed to account for nutrients in the soil and the products of photosynthesis, making Options B and C incorrect. Option C is a distractor.
2	A	Options C and D are incorrect as Eratosthenes himself was based in Alexandria, and this is where he measured the height and angles of shadows. The distance between Syene and Alexandria was carried out by someone else, making the information second-hand data. Option B is a distractor.
3	A	The exclamation mark symbol always represents 'low level toxicity' (Option A). 'Corrosive chemicals' is represented by a hand and bar with burns (Option B), hazardous to aquatic life and the environment features the deceased fish and tree (Option C), and 'fatal or toxic if swallowed, inhaled or in contact with skin' shows a skull and cross bones (Option D).
4	B	The definition provided is that of a placebo (Option B). A control (Option A) is a group in or component of an investigation that is used as a benchmark in comparison to other components where something is being tested. Double-blind (Option C) refers to trials where neither the participants nor the research in contact with them are aware of who is receiving the treatment and who gets the control, and pseudoscience (Option D) is a term that describes a practice that portrays itself as a science, often through complex terminology and processes, but does not meet the criteria for contributing to the greater knowledge and or burden of scientific proof.
5	B	The degree of accuracy printed on the pipette reads 0.06 mL. Option A, C and D are all values that are outside the threshold that this degree of accuracy creates (24.94 – 25.06 mL).
6	A	Edward Jenner's experiments with cowpox led to his development of a smallpox vaccine (Option A). Options B, C and D are all distractors related to other Module 8 case studies.
7	C	Option C is correct as convenience sampling is a type of sample bias that occurs when a sample is selected because it is the most readily available to the researcher, and this is what the student has done by purchasing the first seedlings they see in the store. Sample bias is the tendency to under or over represent a particular group within the sample population (Option A). Voluntary response sampling is a type of sample bias where people are included in a study simply because they are willing to participate (Option D). Option B is a distractor.

8	B	Recording results with an appropriate number of significant figures would help to reduce any errors that may result through rounding up or down during calculations. Option A is incorrect as graphing raw data means that any anomalous results would also be included. Option C is incorrect as any data collected from that investigation may be out of date. Option D is incorrect as having multiple people collect data from the same investigation could increase the chance of an accidental error occurring.
9	C	The optimum temperature for fermentation is at the point where yeast activity is at its highest, that is, at the peak of the curve on the graph. Options A, B and D denote temperatures where yeast activity is not at its highest.
10	C	Conducting a primary investigation allowed Marshall and Warren to collect their own data that could be used to validate their hypothesis and show that H. pylori was responsible for peptic ulcers. Option A is incorrect, as this methodology is likely the least safe way to experiment with live bacteria colonies. Collecting data through experimentation is likely to extend the length of an investigation, making Option B incorrect. Option D suggests that there were no other ways the investigation could have been carried out, but this is not the case.
11	D	Option D is correct as Option A Option B is incorrect Option C is incorrect
12	C	Option C correctly identifies the Land Rights (Northern Territory) Act 1976 as the legislation document that is place to ensure that the traditional landowners maintain control over their land and its resources. Options A, B and D identify other, unrelated, but equally important pieces of legislation that are in place in Australia.
13	D	Pons and Fleischmann failed to allow other scientists access to their methodology (Option D), and as a result, their investigation was unable to be verified or replicated. Option A is incorrect for this reason also. Option B is incorrect as avoiding other possible theories would only help to promote confirmation bias. Option C is incorrect as announcing results and findings before they have been peer reviewed would increase the chance that errors slip through unnoticed.

14	D	Option D is correct. The '14' gives a value of 5 (1 + 4). 'July' being the seventh month gives a value of 7. The year '1991' converts to the number 2 (1 + 9 + 9 + 1 to give 20, then 2 + 0 to give 2). These three values add up to 14 (5 + 7 + 2), which converts to the number 5 when reduced (1 + 4). Options A, B and C are distractors based on other possible life path numbers.
15	A	Although there was likely some sort of confirmation bias evident here (Option B), Option A is still the strongest answer. The stimulus provided describes a conflict of interest where the cigarette industry used their own scientists to look into the risks associated with smoking and then supressed this information. The media (Option D) likely had no impact in this situation. Option D is a distractor.
16	D	Options A, B and C all reflect practices that would be considered to demonstrate a high standard of scientific integrity. Carrying out additional testing after the initial testing, just to confirm that results are correct as suggested in Option D would be considered inappropriate and unnecessary.
17	C	Option C is correct
18	B	Options A, C, and D incorrect
20 swapped	B	The number 100,000,000 can also be written as 108. Identifying this processor speed on the y-axis and following the line across to the graph shows that 1995 (Option B) is the closest year when processor speed was at this rate. Options A, C and D are all distractors.
19	C	Option A suggests that the technology developed for the collider could be used elsewhere, which would be considered a positive impact, as would be improved safety standards (Option B) and providing the ability to collect information about things that can't be physically seen (Option D). Option C is correct as the idea of unpredictable and unforeseen effects of energy production could be considered a negative impact.

Section II

Question 21 (3 marks)

(a) 1 mark

Criteria	Marks
• Identities one hazard associated with the use of hydrochloric acid	1

Sample answer:
Answers will vary.

Exposure to hydrochloric acid may cause respiratory irritation.

(b) 2 marks

Criteria	Marks
• Identifies an appropriate measure that could be implemented when using hydrochloric acid • States how this measure would minimise any risk	2
• Identifies an appropriate measure that could be implemented when using hydrochloric acid	1

Sample answer:
Answers will vary.

The user could wear protective gloves when using hydrochloric acid. This would help prevent the acid from getting on their skin and reduce the risk of burns or irritation.

Question 22 (6 marks)

(a) 2 marks

Criteria	Marks
• Describe the factors that led to Spencer's investigations into microwaves	2
• Provides some relevant information	1

Sample answer:

During World War II, Spencer became an expert in developing magnetrons which were used in radar detection systems. While working on a magnetron, he noticed the chocolate bar in his pocket had warmed up and started to melt.

(b) 1 mark

Criteria	Marks
• Correctly states Spencer's hypothesis	1

Sample answer:

When exposed to microwaves, food samples will heat up.

(c) 3 marks

Criteria	Marks
• Identifies how Spencer deviated from traditional and linear models of scientific methodology in order to test his hypothesis • Provides a link between the necessity of any deviation and further discovery	3
• Identifies how Spencer deviated from traditional and linear models of scientific methodology in order to test his hypothesis	2
• Provides some relevant information	1

Sample answer:

Spencer began to experiment with exposing various food types to microwaves generated by the magnetron. This deviated from traditional and linear methodologies as he used the magnetron in a different way than intended. This testing resulted in working out amounts needed to warm foods and how much was too much. Such untraditional, uncontrolled experimentation with radiation could be dangerous, and exposing food that was likely eaten to this radiation may have gone against ethical regulations. However, if they hadn't deviated in this way, it is unlikely the metal box for controlling microwaves, the microwave oven, would have been developed.

Question 23 (4 marks)

(a) 1 mark

Criteria	Marks
• States what is meant by the phrase *publish or perish*	1

Sample answer:

Publish or perish refers to a phenomenon where academics need to regularly publish their work or risk losing research funding of their job.

(b) 3 marks

Criteria	Marks
• Discusses the implication that the *publish or perish* phenomenon has on the scientific community • Makes clear reference to the stimulus material	3
• Discusses the implication that the *publish or perish* phenomenon has on the scientific community	2
• Provides some relevant information	1

Sample answer:

The "publish or perish" phenomenon has a negative impact on the scientific community. Scientists are incentivised to continually submit articles even if the investigation is inadequate. As the cartoon suggests, this involves 'blowing up' important factors such as accuracy, validity and reliability. The phenomenon increases the likelihood that a scientist may falsify part of their data in order to get it finished before a deadline. The cartoon supports this where it shows that a deadline will eventually 'blow up' any chance of peer review and honesty.

Question 24 (6 marks)

(a) 2 marks

Criteria	Marks
• Identities one plant commonly used by Aboriginal and Torres Strait Islander Peoples for medicinal purposes • States what the plant was used for	2
• Identities one plant commonly used by Aboriginal and Torres Strait Islander Peoples for medicinal purposes	1

Sample answer:

The boiled fruit of the Kakadu plum was used to treat sores and skin infections.

(b) 1 mark

Criteria	Marks
• Correctly states what is meant by the term *bioharvesting*	1

Sample answer:

Bioharvesting refers to the activities involved in collecting organisms from the natural environment to be used as food or for medicinal purposes.

(c) 3 marks

Criteria	Marks
• Discusses possible ethical issues that may arise due to bioharvesting	3
• Identifies possible ethical issues that may arise due to bioharvesting OR • Discusses a single ethical issue that may arise due to bioharvesting	2
• Provides some relevant information	1

Sample answer:

Many Australian native plants are difficult to grow or pollinate and may only be found in small patches of remote areas. These areas may be considered sacred by or have significant meaning to the local Aboriginal and Torres Strait Islander community, so working or removing samples from these areas may not be appropriate. Also, removing large number of plants from an area may upset the biodiversity of the natural ecosystem, which would affect communities living in the area. Finally, some of the knowledge regarding the use of native plants is considered to be Indigenous cultural and intellectual property, meaning that the correct procedures must be followed to gain permission.

Question 25 (4 marks)

(a) 2 marks

Criteria	Marks
• Identifies the difference between emotive advertising and evidence-based claims	2
• Provides some relevant information	1

Sample answer:

Emotive advertising refers to the way a company works to appeal to the feelings (eg. desires, ego, needs, fears ...) of a buyer to encourage a sale. However, evidence-based claims are more factual statements backed by readily accessible scientific research.

(b) 2 marks

Criteria	Marks
• Describes how one of the claims made by the cereal manufacturer could be considered emotional advertising • Makes a clear link between the claim and its effect on a consumer	2
• Provides some relevant information OR • Identifies how one of the claims made by the cereal manufacturer could be considered emotional advertising	1

Sample answer:

The claim 'start your child's day the right way' infers that starting a child's day any other way, for example, providing them with a different breakfast cereal, is incorrect. A parent who is concerned about the wellbeing of their child may be scared into buying this cereal because they desire the best for the child.

Answers may also include:

Title:
The use of the highly emotional 'Super' with links to superheroes makes the name of the cereal beyond the ordinary. The font echoes Superman media so emphasises the link.

Start your child's day the right way!
The use of the exclamation mark creates feelings of excitement and makes it an imperative statement which plays on consumer obedience and wish to do the right thing as it is a command.

Increases alertness and strengthens immunity

‘increases’ and ‘strengthens’ are both positive verbs which convey a sense of action and movement. This is important as the claim is for highly desirable achievements – ‘alertness’ and ‘immunity’. Both have feelings of being better than the ordinary.

Question 26 (6 marks)

(a) 2 marks

Criteria	Marks
• Correctly describes one of Priestley's investigations into oxygen	2
• Provides some relevant information	1

Sample answer:

Priestley placed a mouse in a jar with a small green plant. When the jar was placed in sunlight, the mouse survived for longer than it did without the plant or when it was in the jar with the candle. Priestley concluded that the plant was refreshing the air.

Answers will vary, but may include the following:

- mouse and candle in jar
- mouse and green plant in jar
- mercuric oxide and mercury in sunlight
- inhaling the gas

(b) 4 marks

Criteria	Marks
• Identifies some for AND against points regarding Priestley's methodology • Makes clear reference to Priestley's investigations • Makes a final judgement	4
• Identifies some for AND against points regarding Priestley's methodology • Makes clear reference to Priestley's investigations	3
• Identifies some for OR against points regarding Priestley's methodology • Makes some reference to one of Priestley's investigations	2
• Provides some relevant information	1

Sample answer:

Priestley carried out a several first-hand investigations when looking into the properties of the unknown gas. Carrying out experiments on himself helped to increase his accuracy and the validity of his results. By burning objects in the presence of 'oxygen', he was able to enhance his understanding of the gas's properties i.e. that it was combustible. Although ethically questionable, seeing the effect of oxygen on mice trapped in a jar and inhaling the gas himself, helped to establish a link between 'oxygen' and respiration, and provided evidence that the gas was required to sustain life. Despite the ethical issues involved, Priestley's research enhanced the understanding of the properties of the gas oxygen.

Question 27 (6 marks)

(a) 2 marks

Criteria	Marks
• Provides a definition for systematic error • Describes an example of a systematic error that involves the use of a thermometer	3
• Provides a definition for systematic error • Identifies an example of a systematic error that involves the use of a thermometer	2
• Provides a definition for systematic error OR • Identifies an example of a systematic error that involves the use of a thermometer	1

Sample answer:

A systematic error is an error that is not determined by chance but is introduced by an inaccuracy of an observation or measurement in the investigation. An example would be if the student were to view the thermometer at an incorrect angle and misread the temperature shown due to parallax.

(b) 3 marks

Criteria	Marks
• Compares by discussing the accuracy of analogue and digital thermometers	3
• Identifies differences in the accuracy of analogue and digital thermometers	2
• Provides some relevant information OR • Identifies differences in the use analogue and digital thermometers that are not related to accuracy	1

Sample answer:

Digital thermometers are more precise with the measurement often being to one decimal place rather than whole numbers. These provide an exact number on the screen for the user to read unlike inaccuracies that may be involved with the user trying to read the scale on an analogue thermometer, these also remove any chance of parallax error affecting readings. However, there is a greater chance of sampling error if the user is untrained or if the device is not calibrated correctly. Analogue thermometers are simple to use and do not require any sort of calibration.

Question 28 (7 marks)

(a) 3 marks

Criteria	Marks
• Identifies ALL of the following: – independent variable – dependent variable – two controlled variables.	3
• Identifies TWO of the following: – independent variable – dependent variable – two controlled variables.	2
• Identifies ONE of the following: – independent variable – dependent variable – two controlled variables.	1

Sample answer:

Independent variable: the type of fruit used.
Dependent variable: the percentage water content.
Controlled variables: the temperature of the oven and the size of the fruit cube.
Note, controlled variables may vary

(b) 4 marks

Criteria	Marks
• Discusses the suitability of the materials used based on ALL of the following: – their relevance to the research question – availability – cost – risk • Provides a justification statement that supports the use of materials	4
• Discusses the suitability of the materials used based on ALL of the following: – their relevance to the research question – availability – cost – risk	3
• Discusses the suitability of the materials used based on TWO of the following: – their relevance to the research question – availability – cost – risk	2
• Describes in general terms, the suitability of the materials used based on at least ONE of the following: – their relevance to the research question – availability – cost – risk	1

Sample answer:

The food items chosen by the student are all considered to be fruit, which makes them relevant to the research questions. However, they are quite varied in shape and structure. For example, the skin of the orange is significantly thicker than that of the apple or pear. These differences are likely to have affected their results. The fruits are readily available and inexpensive, which makes them better suited for testing. This allows the student to repeat or expand on the research without fear of the samples or funds running out. If they had used more obscure fruit such as lychees, they may have encountered sourcing issues. The greatest risk involved in the experiment comes with the cutting up of the samples and heating them to remove any water they contain. Cutting the samples with a kitchen knife is low risk and suitable since it is similar to a person preparing a meal at home. Similarly, using an oven set at a low temperature is appropriate as the student would likely be exposed to no more risk that using the same device in their home. The materials chosen by the students for this investigation are suitable based on their relevance to the research question, availability, cost and risk.

Question 29 (8 marks)

(a) 2 marks

Criteria	Marks
• Identities the difference between correlation and causation	2
• Provides a definition for correlation OR causation	1

Sample answer:

Correlation is a connection between two or more things, or a measure of how things are related, whereas causation is where a change in one variable can be proven to affect another variables. Just because two or more variables may correlate with each other does not mean that one necessary causes the other to happen.

(b) 3 marks

Criteria	Marks
• Provides a comprehensive outline of the investigation carried out by researchers that lead to the discovery of the Hawthorne effect	3
• Provides a limited outline of the investigation carried out by researchers that lead to the discovery of the Hawthorne effect	2
• Provides some relevant information	1

Sample answer:

The researchers were watching the workers in the facility to see if there was a way to increase their productivity. They found that productivity increased with higher light levels, so they adjusted light levels to see how they affected the workers. They also found that the productivity of the workers in the control group went up as well, even though their light levels were not changed.

(c) 3 marks

Criteria	Marks
• Explains how the investigation demonstrates how evidence of a correlation can be misinterpreted as causation • Provides clear links to demonstrate understanding of correlation and causation in response	3
• Describes how the investigation demonstrates how evidence of a correlation can be misinterpreted as causation	2
• Provides some relevant information	1

Sample answer:

The researchers assumed that productivity increased because the workers knew that they were being watched and had changed their behaviour, so they did not look bad. Later, they

discovered that this suspected causation was incorrect, and that control group workers had been working harder as the researcher were treating them nicer than their regular bosses, so they were more likely to listen to their opinions and suggestions. There is a correlation between worker productivity and researcher behaviour, but one did not cause a change in the other.

Question 30 (6 marks)

(a) 3 marks

Criteria	Marks
• Provides detailed characteristics of the trends in the graph • Refers to the data in the graph	3
• Identifies some trends in the graph	2
• Provides some relevant information	1

Sample answer:

There was initially a small drop in the oxygen concentration available in the bell jar from the starting 12KPa to 12.5kPa. However, after the first hour the oxygen increased in an upward trend to approximately 18.0kPa by the end of the 48 hours.

(b) 3 marks

Criteria	Marks
• Provides detailed reasons of how this experiment deviated from the traditional model of science • Refers to ethical issues associated with human testing	3
• Identifies how this experiment deviated from the traditional model	2
• Provides some relevant information	1

Sample answer:

The experiment above utilises a human subject to test Priestly's hypothesis regarding the importance of oxygen for life on Earth. Without ethical approval, this investigation is dangerous and the results may not be valid. The hypothesis of this investigation is not clear and simply recreating his experiment with a human subject, rather than the mouse is a deviation from the linear methodology.

Question 31 (4 marks)

Criteria	Marks
• Describes how scientific language and processes can be manipulated to sway public opinion about the effectiveness of iridology • Provides a clear link between language and processes and public opinion about effectiveness	4
• Describes how scientific language and processes can be manipulated to sway public opinion about the effectiveness of iridology	3
• Identifies some issues with the validity of iridology as a science	2
• Provides some relevant information	1

Sample answer:

Iridology readings adopt a scientific-like diagnosis by telling an individual there may issues with a specific area of the body although do not work to provide a specific ailment. Looking at the placement of different body parts on the chart shows this and also, that it would be easy to create a reading to confirm a patient's beliefs. Many of the iridology charts used are created to resemble other medical charts and diagrams that are often used by or found in the offices of medical professionals. The use of 'ology' in the word iridology also promotes a false sense of scientific validity as it reminds the public of established branches of science such as biology.

Question 32 (4 marks)

Criteria	Marks
• Describes a technology that could be incorporated into a building's design to make it more earthquake resistant • Identifies one of Newton's laws of motion • Provides a link between the described technology and the identified law of motion	4
• Describes a technology that could be incorporated into a building's design to make it more earthquake resistant • Identifies one of Newton's laws of motion	3
• Identifies a technology that could be incorporated into a building's design to make it more earthquake resistant • Identifies one of Newton's laws of motion	2
• Provides some relevant information. OR • Identifies a technology that could be incorporated into a building's design to make it more earthquake resistant OR • Identifies one of Newton's laws of motion	1

Sample answer:
Answers will vary.

Base isolation systems could be incorporated into a building's structure to help minimise any movement due to seismic activity. These systems 'float' buildings above their bases by resting them on top of a system of shock-absorbing objects, such as bearings, padded cylinders, or springs. Newton's 1st Law of Motion states that a body remains at rest, or continues to move in the same direction with the same speed, unless acted upon by a force. Using a base isolation system would allow the building's foundations to move when acted upon by the force generated by an earthquake. It would prevent movement of the actual building by isolating it from the forces that may cause it to start moving.

Question 33 (4 marks)

Criteria	Marks
• Discusses how the development of flight has affected the public image of science • Provides an appropriate link to a particular event that contributed to the development of flight	4
• Discusses how the development of flight has affected the public image of science • Identifies a particular event that contributed to the development of flight	3
• Describes how the development of flight has affected the public image of science	2
• Provides some relevant information OR • Identifies a particular event that contributed to the development of flight	1

Sample answer:

Each of the events that led to the development of flight as a common mode of travel has had a mostly positive affect on the public image of science. When Orville and Wilbur Wright successfully flew their Kitty Hawk Flyer just under 260 metres in 1900, the public were fascinated and likely amazed by the physics involved in allowing something that was once considered impossible to occur. This is particularly true with the general public who may not have been following the process over time and only come across 'big' headlines in the media. These days, most people trust the design of an aeroplane and do not think about how they actually work – they trust in the science and engineering that makes them possible. Most concerns are only raised when there is an accident or incident, but the necessity of travel often makes these concerns insignificant.

Question 34 (4 marks)

Criteria	Marks
• Explain the difference between a placebo group and a control group, giving thorough definitions of both. • Provides at least TWO examples of each and linking them to the placebo and control group. Change to ONE	4
• Explain the difference between a placebo group and a control group, giving simple definitions of both. • Provides at least TWO examples of each and linking them to the placebo and control group. Change to ONE OR • Explain the difference between a placebo group and a control group, giving thorough definitions of both. • Provides one example and linking it to either the placebo or control group	3
• Provides simple definitions of both placebo and control groups. • Gives an example of either group with no linking OR • Provides simple definition of either placebo and control group • AND: links an example to their definition.	2
• Provides any relevant information	1

Sample answer:

In a clinical trial, the placebo group is a group of participants who receive a fake treatment (usually a sugar pill or saline solution) that has no therapeutic effect. The control group, on the other hand, is a group of participants who receive a standard treatment or no treatment at all. The purpose of both groups is to provide a baseline for comparison with the experimental group that receives the actual treatment.
The relationship between the placebo and control groups is important because it helps researchers determine whether the treatment being tested is effective. If the treatment group shows a significant improvement over the placebo and control groups, it suggests that the treatment is effective. If there is no significant difference between the treatment group and the placebo/control groups, then the treatment may not be effective.

For example, if you're regularly given the same arthritis pill to relieve stiff, sore joints, you may begin to associate that pill with pain relief. If you're given a placebo that looks similar to your arthritis pill, you may still believe it provides pain relief because you've been conditioned to do so.

Question 35 (8 marks)

(a) 5 marks

Criteria	**Marks**
• Identifies named technology • Thoroughly describes the related scientific understanding, theory, model or law • Relates the scientific understanding to the development of the technology • Provides a judgement	5
• Identifies named technology • Describes the related scientific understanding, theory, model or law • Relates the scientific understanding to the development of the technology • Provides a judgement	4
• Identifies named technology • Identifies scientific theory, model or law • Relates the scientific understanding to the development of the technology • Provides a judgement	3
• Relates scientific understanding, theory, model or law to a relevant technology	2
• Provides some relevant information	1

Sample answer:

Technology: Base Isolations system (Anti-seismic technology)

Newton's three Laws of motion describe how forces and objects interact with each other. Newton's first law states that a body in motion will stay in motion and a body at rest will stay at rest unless acted on by an outside force - this is called inertia. A building has a large mass, and will stay at rest until acted upon by a large force, like an Earthquake. In an earthquake, the bottom parts of the building move and the upper levels remain still, due to inertial force. This puts significant strain on the structure of the building and can lead to significant damage. One of the main causes of damage and human injury or death is due to the collapse of buildings not strong enough to withstand the shaking of an earthquake.

Scientists and engineers have used this knowledge of Newton's Laws to develop and implement anti-seismic technology such as base isolation systems. This technology is incorporated into buildings in earthquake zones. Base isolation systems separate the building from the ground, so whilst the ground shakes during an earthquake, the building stays still. This prevents or significantly limits the damage an earthquake can do to large buildings, which in turn reduces the economic impact of earthquakes and the impact on human wellbeing and the health care system.

(b) 3 marks

Criteria	Marks
● Identifies appropriate technology ● Describes how the technology impacts the development of the structure of DNA	3
● Outlines a relevant technology	2
● Provides some relevant information	1

Sample answer:

X-ray diffraction played a crucial role in determining the structure of DNA. Rosalind Franklin used X-ray crystallography to study the structure of DNA fibres, which provided critical data suggesting that DNA had a helical structure. In 1953, Watson and Crick proposed a model for the structure of DNA based on Franklin's data, which suggested that DNA consisted of two complementary strands of nucleotides that formed a double helix. X-ray diffraction images, including Photograph 51 taken by Franklin, provided key evidence supporting the Watson-Crick model. The discovery of the structure of DNA using X-ray diffraction has had a significant impact on our understanding of genetics and molecular biology.

2023 Investigating Science Trial Examination BWB Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Practical Investigations to Obtain Primary Data	INS12-2, INS12-12
2	1	Different Types of Scientific Investigations	INS12-12
3	1	Scientific Investigation and Technology	INS12-2, INS12-4
4	1	Impacts on Investigations	INS12-5
5	1	Scientific Investigation and Technology	INS12-2
6	1	Incidents, Events and Science	INS12-5
7	1	Testing Claims	INS12-5
8	1	Reporting	INS12-12
9	1	Scientific Investigation and Technology	INS12-4
10	1	Practical Investigations to Obtain Primary Data	INS12-2, INS12-12
11	1	Impact on investigations	INS12-2, INS12-14
12	1	Regulation of Scientific Research	INS12-5
13	1	Science as Self-correcting – the Issues	INS12-14
14	1	Reading Between the Lines	INS12-6
15	1	Reading Between the Lines	INS12-5
16	1	Reliability and Validity	INS12-2
17	1	Incidents, Events and Science	INS12-15
18	1	Incidents, Events and Science	INS12-15
19	1	Scientific Investigation and Technology	INS12-4
20	1	A Continuous Cycle	INS12-13

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	1	Scientific Investigation and Technology	INS12-2, INS12-4
21 (b)	2	Scientific Investigation and Technology	INS12-2, INS12-4
22 (a)	2	Practical Investigations to Obtain Primary Data	INS12-1, INS12-12
22 (b)	1	Practical Investigations to Obtain Primary Data	INS12-1, INS12-12
22 (c)	3	Practical Investigations to Obtain Primary Data	INS12-1, INS12-12
23 (a)	1	Science as Self-correcting – the Issues	INS12-5
23 (b)	3	Science as Self-correcting – the Issues	INS12-5
24(a)	2	A Continuous Cycle	INS12-13
24 (b)	1	A Continuous Cycle	INS12-13
24 (c)	3	A Continuous Cycle	INS12-13
25 (a)	2	Testing Claims	INS12-5, INS12-14
25 (b)	2	Testing Claims	INS12-5, INS12-14
26 (a)	2	Different Types of Scientific Investigations	INS12-12
26 (b)	4	Different Types of Scientific Investigations	INS12-12
27 (a)	3	Scientific Investigation and Technology	INS12-2
27 (b)	3	Scientific Investigation and Technology	INS12-2
28 (a)	3	Reliability and Validity	INS12-2, INS12-3
28 (b)	4	Reliability and Validity	INS12-2, INS12-3
29 (a)	2	Evidence-based Analysis	INS12-5, INS12-14
29 (b)	3	Evidence-based Analysis	INS12-5, INS12-14
29 (c)	3	Evidence-based Analysis	INS12-5, INS12-14
30 (a) (b)	3 3	Different types of scientific investigations Practical investigations to obtain primary data M5	INS12-5, INS12-12 INS12-12
31	4	Reading Between the Lines	INS12-7
32	4	A Continuous Cycle	INS12-13
33	4	Incidents, Events and Science	INS12-15
34	4	Impacts of investigations M7	INS12-14
35	8	Scientific Theories and Technology M6	INS12-13