Student number: ……..

Pymble Ladies' College

2022

Trial Higher School Certificate Examination

Investigating Science

General Instructions

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

Total marks: 100

Section I – 20 marks (pages 2–12)

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

Section II – 80 marks (pages 13–32)

- Attempt Questions 21–34
- Allow about 2 hours and 25 minutes for this section

Section I

Attempt Questions 1-20

Allow about 35 minutes for this section

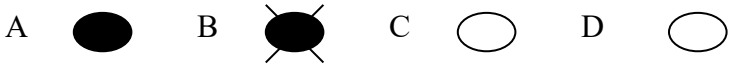
Use the multiple-choice answer sheet for questions 1-20. You will find this at the back off the examination. You may detach the multiple-choice answer sheet.

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

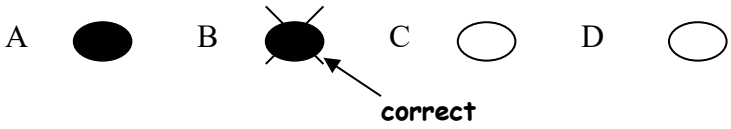
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9



If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.



If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



1 What does the following statement define?
"The evaluation of scientific, academic, or professional work by others working in the same field."

A. Validation

B. Peer review

C. Scientific debate

D. Feasibility study

2 An American engineer, Percy Spencer, was testing electronic equipment used in radar that produced microwaves. He noticed a peanut butter candy bar in his pocket had begun to melt. He later put some kernels of corn (maize) into this equipment and switched it on.
Which is the most likely hypothesis for this investigation?

A. Microwaves will harm living things

B. Microwaves will penetrate corn kernels

C. Microwaves can be used to cook foods

D. Microwaves can be used to heat homes

3 Which of the following statements best applies to the Scientists Marshall and Warren who were awarded a Nobel prize in 2005?

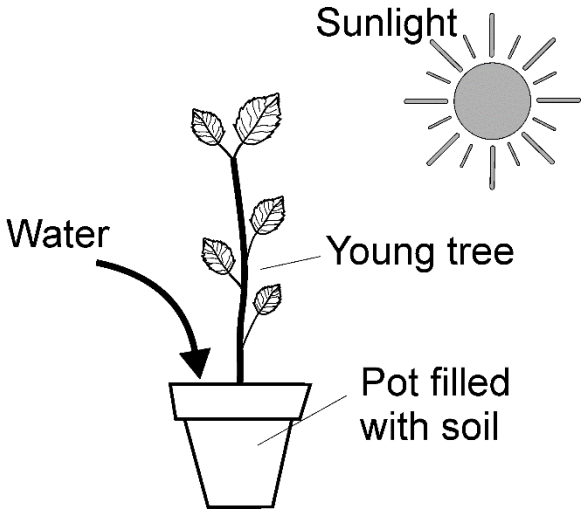
A. They discovered new causes of food poisoning.

B. They showed that a bacterium could cause stomach ulcers.

C. They deliberately infected patients with the organism *Helicobacter pylori.*

D. Their hypothesis was that stress was the major cause of stomach ulcers.

4 A Year 12 class decided to set up an experiment using apparatus as shown below. They weighed a young tree, then weighed some dry soil. They placed the soil and plant in a plant pot and watered it at regular intervals. At the end of the school year, they re-weighed both the plant and the soil, after the soil had been dried.



Which statement about this investigation is most likely the reason for this investigation?

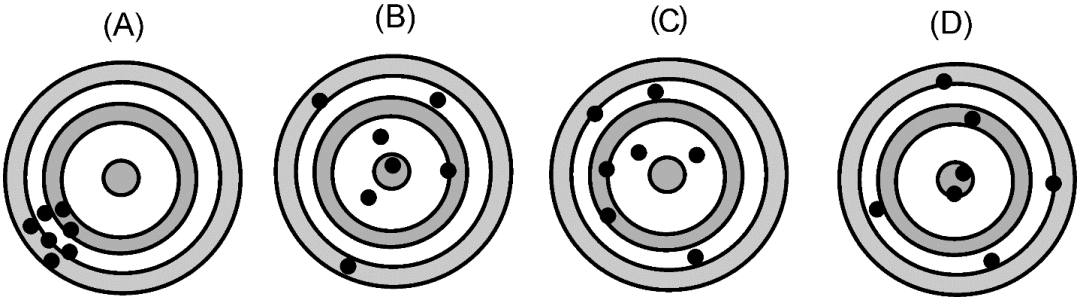
A. The teacher wanted the class to learn how to weigh things.

B. The students were investigating the role of sunlight in photosynthesis.

C. The students were modelling van Helmont's experiment on plant growth.

D. The students were investigating how much water is needed for plants to grow.

5 A student was explaining accuracy and reliability using shots hitting targets as shown below.



Which target best illustrates results that are reliable but not accurate?

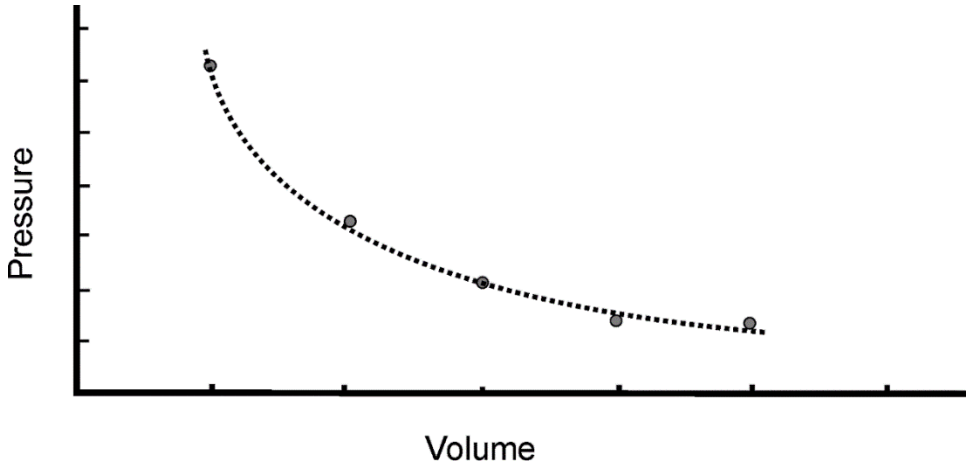
A. Target A

B. Target B

C. Target C

D. Target D

6 A group of students measured the pressure of a fixed mass of gas at different volumes. From their results they produced the graph shown below.



Which statement correctly describes the graph?

A. Increasing the pressure on a gas increases its volume

B. Small and large volumes of gases cannot be measured

C. Pressure and volume of a gas are inversely proportional

D. There is no relationship between pressure and volume of a gas

7 Which technique played a major role in the discovery of the structure of DNA?

A. Robotics

B. Iridology

C. X-ray diffraction

D. Genetic modification

8 The number of toilet breaks taken by workers in a factory was measured over a period of three months. Closed – circuit TV (CCTV) cameras were then installed in plain sight to monitor the workers. Again, for three months the number of toilet breaks taken by the workers was measured. It was found that, on average, the number of toilet breaks taken had decreased by around 30%. Which statement correctly refers to this investigation?

A. This is an example of the Hawthorne effect

B. The change in behaviour is not enough to be significant

C. Workers feel more secure when they are being watched by CCTV

D. The time taken for observations to be made was insufficient to come to any conclusion

9

"Wake up your energy!"

Smokers everywhere are turning to our brand of cigarettes for their delightful "energizing effect".
You'll enjoy these too! And remember the finest- MOST EXPENSIVE TOBACCO- domestic and imported -used in the manufacture of this brand never gets on your nerves..... never tires your taste.

The text above came from a typical advertisement for a brand of cigarettes in the 1930s. Advertising of tobacco products has been banned in Australia, with limited exceptions, since 1992.

Which is the most likely reason for this?

A. The tobacco used in the 1930s did not cause cancer
B. Because it promotes a product that is addictive and lethal
C. Cigarette makers today do not need to advertise their product
D. Manufacturers are now not allowed to make misleading claims

10 There are many "celebrity influencers" in the world. These are well known personalities who promote (for a fee) services or goods to their fans on social media.

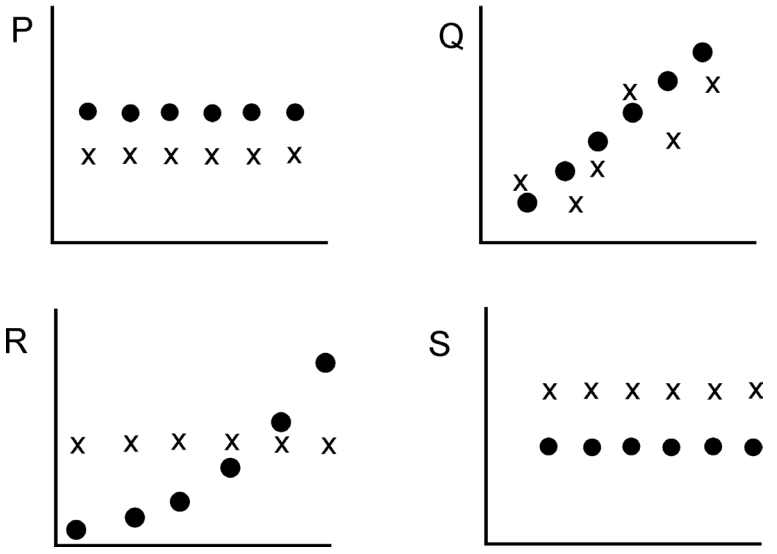
Which is the best description of this?

A. Mozart effect
B. The Halo effect
C. Truth in advertising
D. Using statistical data

11 Two types of errors in scientific investigations are random errors and systematic errors. Examples of these are shown in graphs P, Q, R and S.

● Correct value

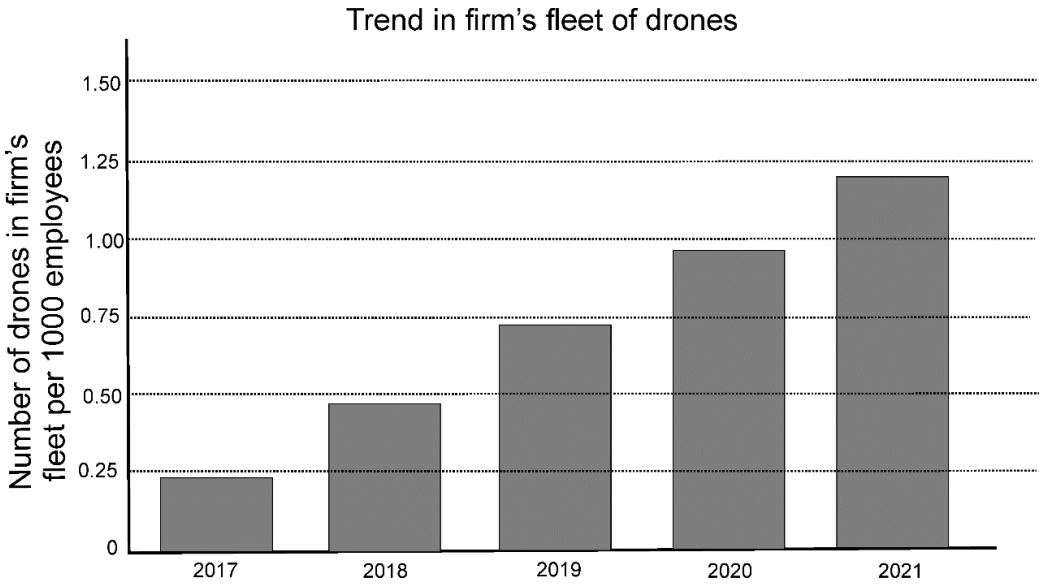
x Recorded value



Which response correctly identifies the types of error shown in these graphs?

	P	Q	R	S
A.	Random	Systematic	Random	Random
B.	Systematic	Random	Systematic	Random
C.	Systematic	Random	Systematic	Systematic
D.	Random	Systematic	Systematic	Systematic

12 A large internet retail store trialled using drones to deliver packages. The graph shows how the number of drones compared to their human employees in a particular year.



Which statement best corresponds with the information on the graph?

A. The firm used approximately 240 drones in 2017

B. Drones are more efficient at delivering items than people

C. The number of employees declined every year from 2017 to 2021

D. The proportion of drones used had increased by approximately 500% from 2017 to 2021

13 The following data were collected about heart rate and exercise from a large number of participants.

Group number	*Age (years)*	*Sex*	*Average weight (kg)*	*Average resting heart rate before exercise (beats/min)*	*Average resting heart rate after 2 mins of exercise (beats/min)*
1	22	Male	70	70	125
2	22	Female	65	75	135
3	40	Male	75	77	140
4	40	Female	75	80	150
5	60	Male	85	85	135
6	60	Female	85	80	145

Which statement is consistent with the data obtained?

A. Men always exercise.

B. Men have a higher heart rate at all times.

C. Females weigh less than men at all ages.

D. Females have a greater increase in heart rate than men after exercise.

14. Christian Doppler was an Austrian mathematician and physicist. He is well known for developing an important principle known as the Doppler effect.

What was the primary method Doppler used to develop this principle?

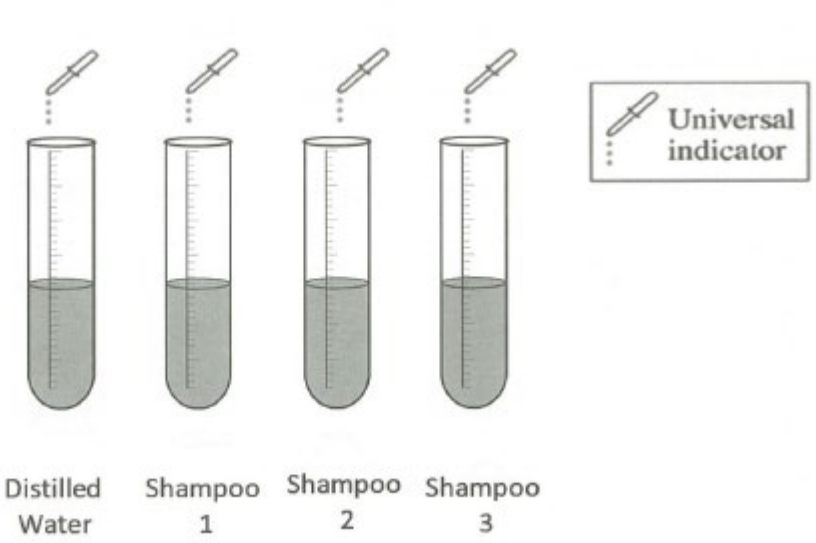
A. Careful examination of spectral lines on photographic plates

B. Mathematical calculations based on the angles of shadows made by tall poles in cities separated by large distances

C. Observation and identification of notes made by trumpets on approaching and receding trains as he stood on a station

D. Observation of the change in spectral lines over time as a planet in the solar system moved relative to another planet

15 An investigation was carried out to measure the pH of shampoos.



From the image above, identify the independent variable and the controlled variable for the investigation.

	Independent variable	**Control**
A.	pH	Distilled water
B.	Shampoos	Distilled water
C.	Shampoos	Universal indicator
D.	Universal indicator	pH

16. A student is planning a first-hand investigation to test the reaction rates of different chemicals at various temperatures. The student wants to view the potential hazards that each chemical possesses. Where would the student find this information?

A. Safety Data Sheets

B. Journal of Hazardous Materials

C. Work Health and Safety Act 2011

D. Occupational Health Guidelines 1992

17. Some scholars reserve the term 'experiment' for study designs that include a control group.

Which of the following is a correct statement about the control group.

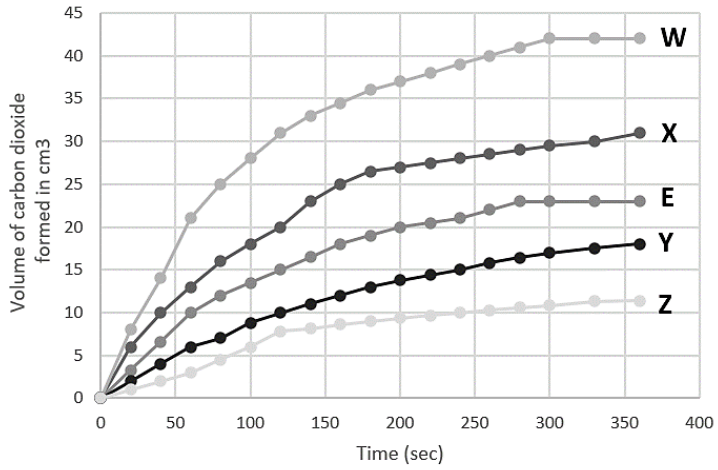
A. The control group is used to establish the reliability of an experiment
B. Inclusion of a control group removes all possibility of making an erroneous conclusion
C. The control group is used to establish cause-and-effect relationship by isolating the effect of the dependent variable
D. Inclusion of a control group allows a researcher to determine if a treatment has a significant effect on an experimental group

18. Through meta-analysis researchers can combine smaller peer-reviewed studies, essentially making them into one big study which may help show cause and effect.

Which response correctly identifies the impact of meta-analysis on evidence-based healthcare.

A.	Decreases bias	Increases sample size	Decreases effect of sample selection
B.	Increases bias	Increases sample size	Decreases effect of sample selection
C.	Decreases bias	Increases accuracy of estimates	Increases effect of sample selection
D.	Increases bias	Decreases accuracy of estimates	Increases effect of sample selection

19. The graph below shows the rate of carbon dioxide production over 6 minutes, after 10 millilitres of hydrochloric acid was added to 1 gram of marble chips (calcium carbonate). X represents the original experiment at room temperature. W, E, Y and Z represent experiments performed at different temperatures.



Which response is a correct statement?

A. W, X, E, Y, Z all have the same initial reaction rate

B. E, Y, Z are reactions performed above room temperature

C. W shows the results for the highest temperature, and Z the lowest temperature of reaction

D. Z shows the results for the highest temperature, and Z the lowest temperature of reaction

20. The table below shows information on radioactive isotopes.

Radioactive isotope	**Type of radiation**	**Half-life**	**Penetration through human flesh**
V	Alpha	300 years	2 mm
W	Beta	7 hours	60 mm
X	Gamma	7 hours	> 10 m
Y	Alpha	9 seconds	2 mm

Identify the isotope doctors use to track blood flow through patients using a detector outside the body.

A. V

B. W

C. X

D. Y

Section II

80 marks
Attempt Questions 21–34
Allow about 2 hours and 25 minutes for this section

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Question 21 (3 marks)

What is Numerology?

The name says it all! This is an ancient science that helps us to better understand the world around us. Numbers are all around you every day, and they each influence the different areas of your life. Numerology draws meaning from the various numbers, number combinations and letters that are linked to your life. By observing the numerical patterns in our daily lives, we can see the underlying patterns of the universe.

A student was doing some research on numerology and came across the material shown above on a website. Would you agree that numerology is a science? Justify your answer. **3**

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Question 22 (5 marks)

The scientific method is a procedure that has characterised Science since the 17th century.

(a) Give the principal steps involved in the scientific method, showing the sequence and how they are connected. You may use a flow chart. **3**

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(b) An important part of a scientific report is the inclusion of relevant data. This data can be quantitative or qualitative. Giving examples, outline the difference between these two forms. **2**

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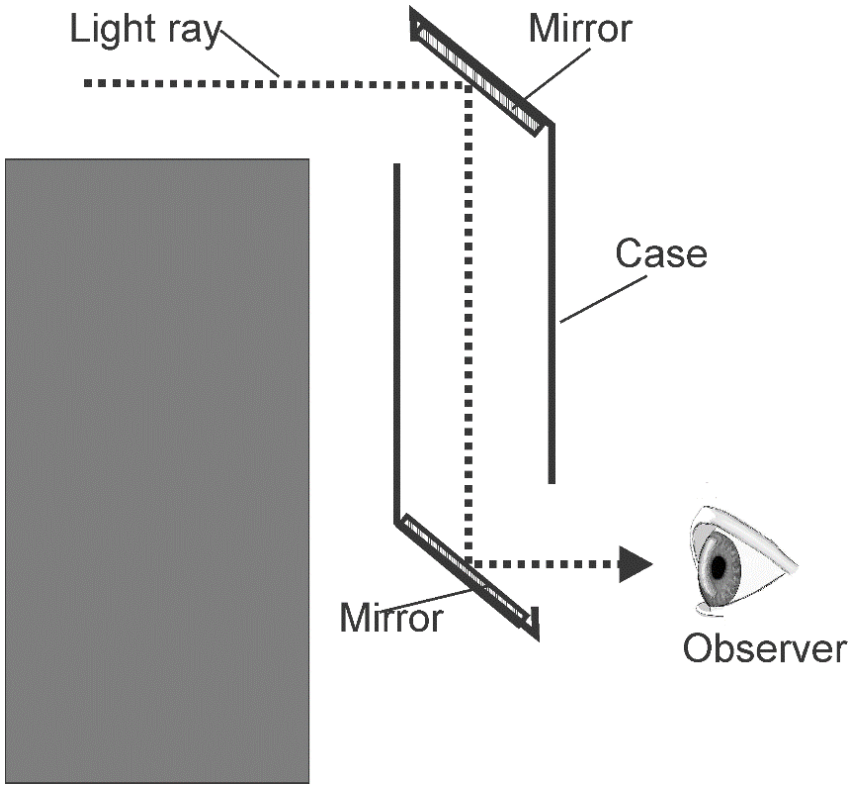
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Question 23 (6 marks)

The diagram shows a simple version of a periscope made out of two plane mirrors. This enables an observer (e.g. behind a high obstacle) to see objects that are otherwise out of sight.



(a) Describe the scientific principle involved in this device. **3**

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Question 23 continues on the next page

Question 23 (continued)

(b) Identify another named optical device that uses the same principle in part a). Outline its purpose and how it works. **3**

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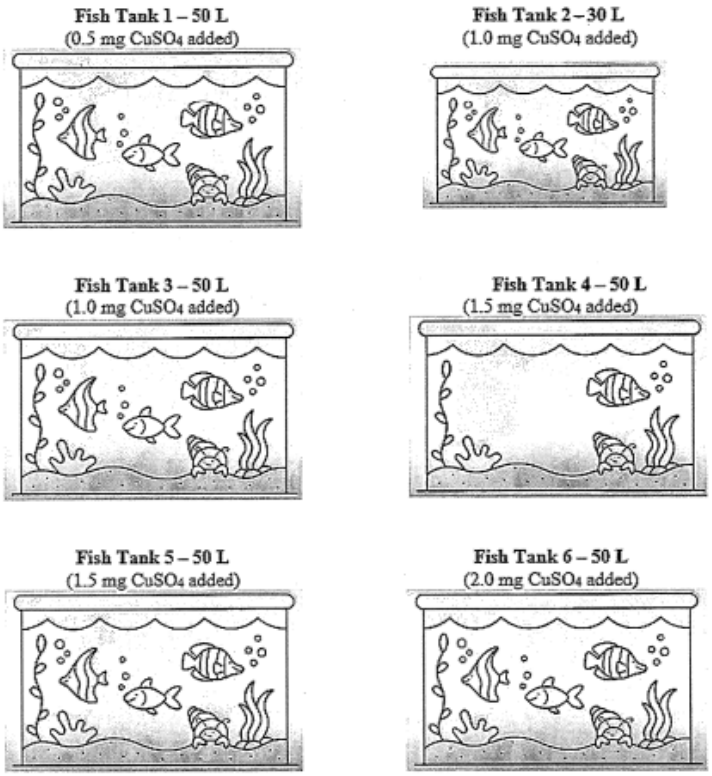
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Question 24 (5 marks)

A practical investigation was carried out to determine the effect of adding a solution of copper sulfate to kill unwanted algae that builds up in fish tanks. It is known that as long as the concentration of copper sulfate is kept to below 5.0 mg the fish will not be affected.



a) Identify the:

i. dependant variable: ……..…… **1**

ii. independent variable: …… **1**

b) Justify which of the fish tanks shown should be used to test the hypothesis fairly. **3**

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Question 25 (7 marks)

A group of students were sitting eating lunch at school and were discussing their favourite flavour of potato chips. In the debate, one student said, "They all taste the same anyway, just lots of salt. I bet you couldn't tell the flavour if you couldn't see the packet." After further discussion, they decided that this would make a good investigation to carry out as a science project.

After consultation with their science teacher, the class gathered the necessary equipment and carried out their investigation. One student's report is reproduced below.

Can you tell the difference?

Aim: To see if people can tell the flavour of potato chips if they don't already know what they are supposed to be.

Hypothesis: Students will be able to correctly identify the plain chips as only salt is added to them and will not correctly identify the other flavours.

Apparatus: Packets of chips (all the same brand) of different flavours, bowls, students.

Method: We got chips with these flavours: plain (salt), BBQ, chicken and cheese and onion. We put them into separate bowls labelled "A", "B", "C" and "D". We got students to come in and taste the chips and try to identify the flavours. They knew what the four flavours were but didn't know which were which. We had a total of 16 students tasting the chips.

Results: 13 students correctly identified the plain chips, 11 students identified the BBQ flavour, 8 students got the chicken flavour and 10 got the cheese and onion.

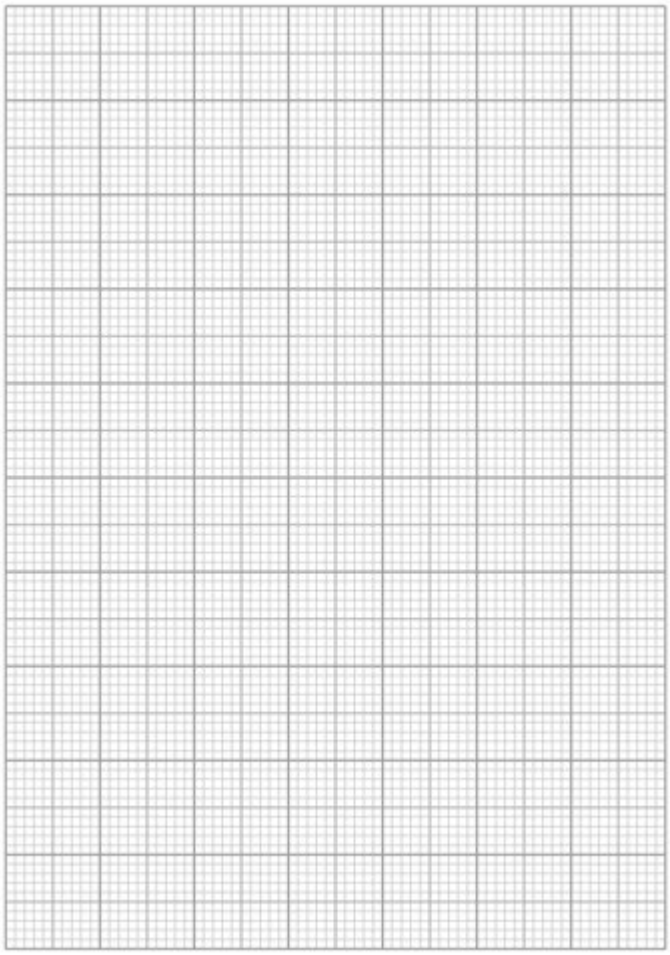
Conclusion: Some flavours of chips are easier to identify than others.

(a) Tabulate the results collected. **3**

Question 25 continues on the next page

Question 25 (continued)

(b) Graph the data in an appropriate form, using the grid below. **4**



Question 26 (4 marks)

In the last hundred years or so, our views on the Earth's geology have changed dramatically. Using an example(s), discuss how computerised simulations and models have helped us understand the Earth's geological history. **4**

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Question 27 (9 marks)

You have designed and carried out a practical investigation to measure the effect of changes in temperature on the volume of a gas.

(a) Outline how you carried out the investigation, identifying any apparatus used. **3**

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(b) Outline the independent variable, the dependent variable and a controlled variable. **3**

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(c) Give TWO examples of the limitations of the technologies used in this investigation. **2**

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Question 27 continues on the next page

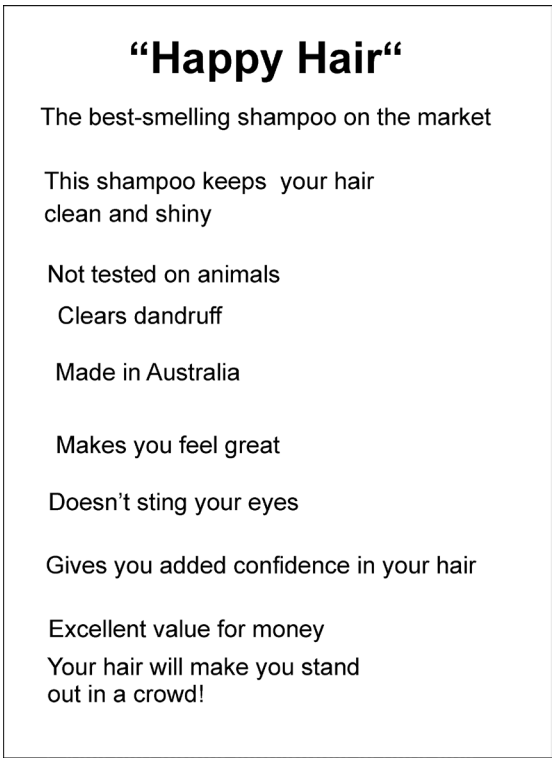
Question 27 (continued)

(d) Outline ONE way you ensured the safety of yourself and others while you carried out this investigation. **1**

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Question 28 (5 marks)



A manufacturer made various claims about their shampoo as shown on the label above. Advertising can be divided into two types: emotive advertising and evidence-based claims. Using examples from the shampoo label, compare these two types of advertising. **5**

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Question 29 (6 marks)

A common statement in scientific research is: "correlation doesn't imply causation." Using the 1991 study that linked hormone replacement therapy to coronary heart disease **and** another example, explain the difference between correlation and causation. **6**

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Question 30 (6 marks)

Sarah's pet budgerigar loves sunflower seeds. Sarah has noticed that the cheaper brand of birdseed that she sometimes buys seems to have fewer sunflower seeds than the more expensive brand.

She conducts an experiment to test her hypothesis. She weighs out a sample of each bird seed brand, then removes the sunflower seeds and weighs them separately. She then calculates the percentage weight of sunflower seeds compared to the total weight of birdseed.

(a) Write a hypothesis for Sarah's investigation. **2**

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(b) Evaluate the impact that sample size and sample selection might have had on the validity and reliability of Sarah's investigation. **4**

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Question 31 (4 marks)

> *"Scientific studies have proven that the antioxidants in the Gubinge (Kakadu plum) are especially powerful with Gallic and Ellagic acid in a form easily taken up by the body and known for their anti-inflammatory, anti-bacterial and anti-fungal properties."*
>
> *Website: Kimberley Wild Gubinge, The world's finest Kakadu plum – The Fruit.*

Scientists are becoming increasingly aware of the value of Indigenous knowledge in relation to medicinal uses of plants through bio-harvesting.

Use your understanding of Scientific regulation in research, to discuss the importance of protection of Indigenous cultural and intellectual property. **4**

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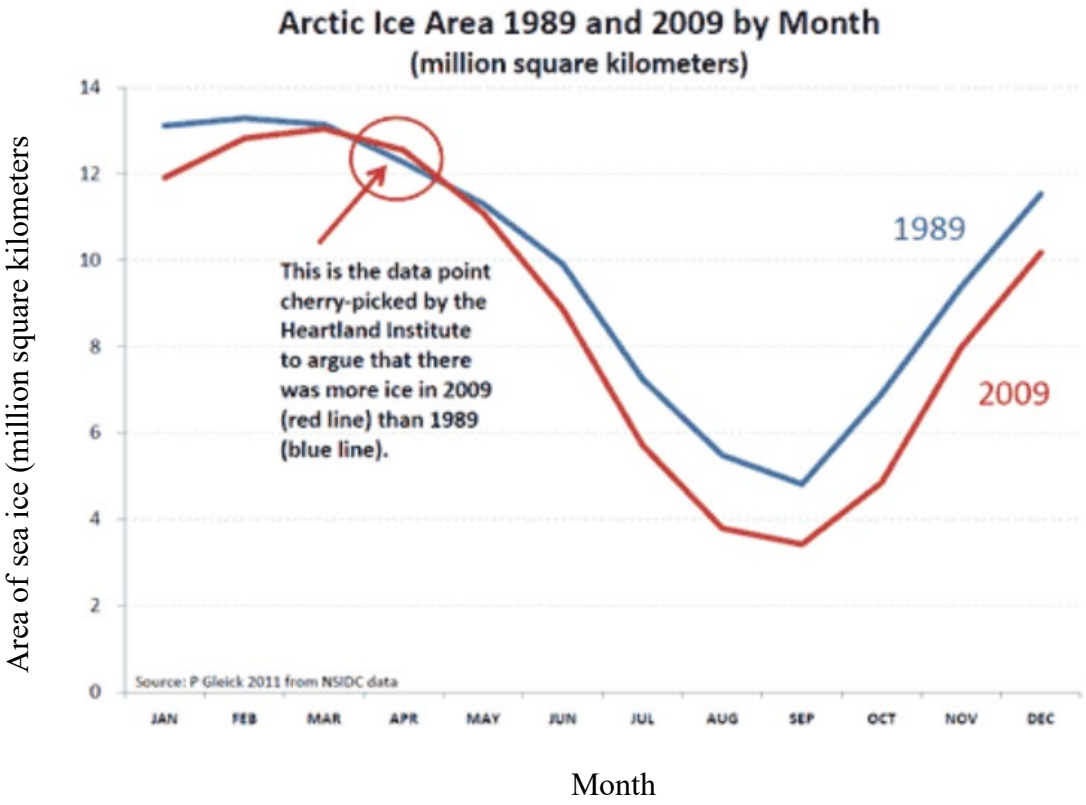
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Question 32 (7 marks)

With reference to the graph below, analyse how conflicts of interest can result in scientific evidence being suppressed, misinterpreted or misrepresented and discuss measures to counteract such conflicts. In your response, refer to climate change and the fossil fuel industry. **7**



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Question 32 continues on the next page

Question 32 (continued)

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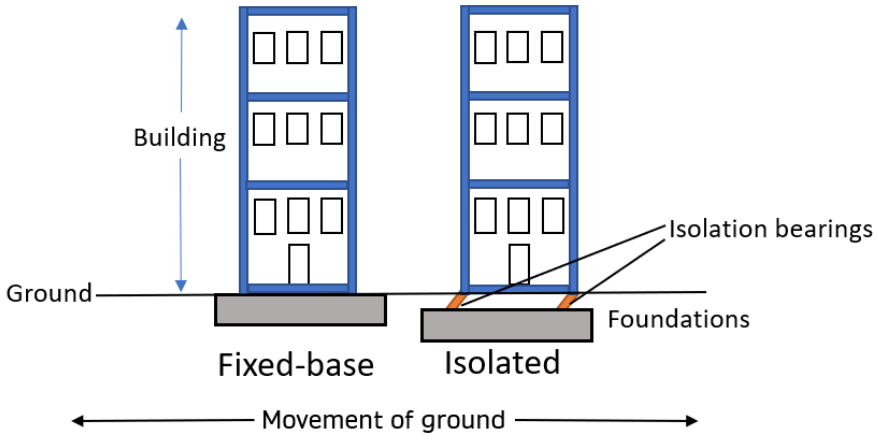
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Question 33 (7 marks)

Scientists and engineers have developed technological solutions to reduce damage to buildings in earthquake prone regions. Base isolators (shown in the figure below) are one such technology.



(a) On the diagram above annotate the direction of forces that are acting upon the building. **2**

(b) How can base isolators reduce the likelihood of a building collapsing during an earthquake? You may like to use a diagram and annotations to illustrate your answer. **2**

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Question 33 continues on the next page

Question 33 (continued)

(c) Identify one of Newton's laws the base isolators seek to mitigate. Justify your answer.

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Question 34 (6 marks)

"[Priestley] systematically analyzed the properties of different "airs" using an inverted container on a raised platform that could capture the gases produced by various experiments below it. The container could also be placed in a pool of water or mercury, effectively sealing it, and a gas tested to see if it would sustain a flame or support life.

In the course of these experiments, Priestley made an enormously important observation. A flame went out when placed in a jar in which a mouse would die due to lack of air. Putting a green plant in the jar and exposing it to sunlight would "refresh" the air, permitting a flame to burn and a mouse to breathe. "Perhaps," Priestley wrote, "the injury which is continually done by such a large number of animals is, in part at least, repaired by the vegetable creation." Thus, he observed that plants release oxygen into the air — the process known to us as photosynthesis.

On August 1, 1774, he conducted his most famous experiment. Using a 12-inch-wide glass "burning lens," he focused sunlight on a lump of reddish mercuric oxide in an inverted glass container placed in a pool of mercury. The gas emitted, he found, was "five or six times as good as common air." In succeeding tests, it caused a flame to burn intensely and kept a mouse alive about four times as long as a similar quantity of air."

Website: https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/josephpriestleyoxygen.html

(a) Justify the suitability of the data collected in TWO of Priestley's experiments. **3**

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Question 34 continues on the next page

Question 34 (continued)

(b) Identify ONE of Priestley's experiments that would not be able to be conducted today. Assess the reasons for your choice. **3**

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END OF EXAM

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Student Number:……..

INVESTIGATING SCIENCE 2021 – MULTIPLE-CHOICE ANSWER SHEET

ATTEMPT ALL QUESTIONS

Question	**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 ⬭