Student number: …….

Pymble Ladies' College

2019

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 2–13)**
- Attempt Questions 1–20
- Allow about 35 minutes for this section
- **Section II – 80 marks (pages 14–33)**
- Attempt Questions 21– 32
- 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. Van Helmont (1580-1644) was one of the first people to scientifically investigate plant growth. He measured the mass of a seedling and the dry soil in which it was placed and watered the plant regularly over a period of 5 years. After this time, he found that the mass of the plant had increased considerably, but very little mass was lost by the soil.
What was the conclusion he reached from this experiment?

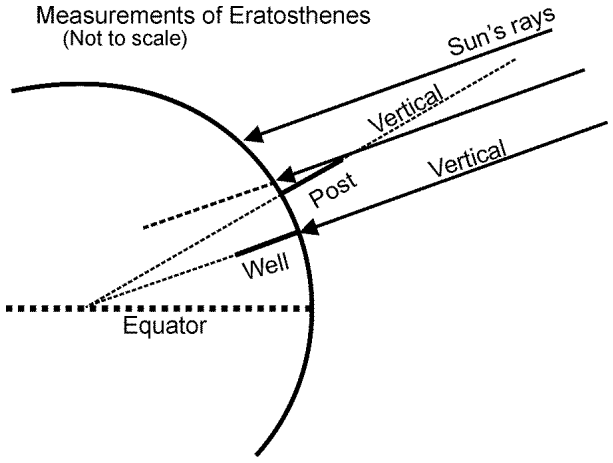
(A) Air provides the most nutrition for plants.

(B) Only water provides nutrition for plants.

(C) Soil provides the most nutrition for plants.

(D) You need to grow and measure plants for a long time before you can make conclusions.

2. The diagram below represents a simplified version of the calculations of Eratosthenes (276 BC - 194 BC).



The post was at Alexandria and the well was at Syene (Aswan).
What was he estimating?

(A) The distance from the sun to the earth.

(B) The circumference of the earth.

(C) The distance between the two towns.

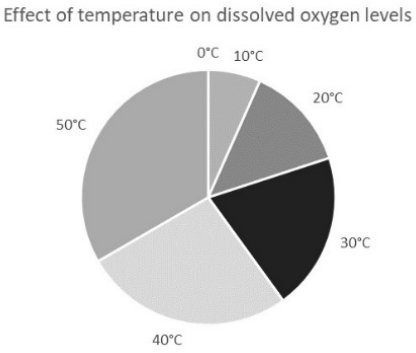
(D) The time difference between the two towns.

3. A student was investigating the effect of temperature on the amount of dissolved oxygen in water. She did this by placing an oxygen probe into a beaker of ice, then gently heating it. The student placed the information in the table below.

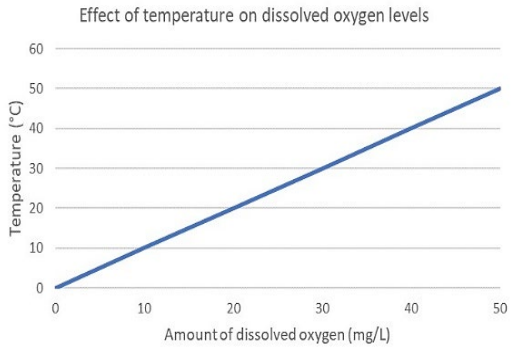
Temperature (°C)	*Amount of dissolved oxygen* (mg/L)
0	22
10	16
20	11
30	8
40	6
50	4

Which of the following graphs best represent the effect of temperature on the amount of dissolved oxygen in water?

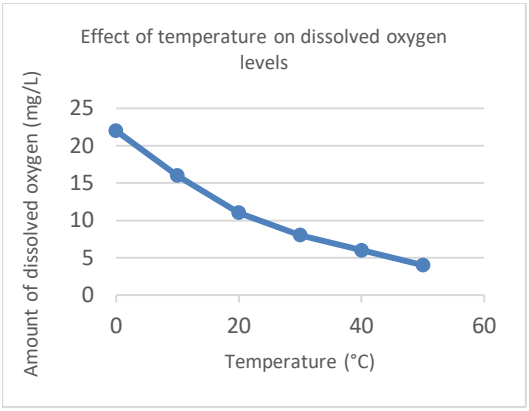
(A)



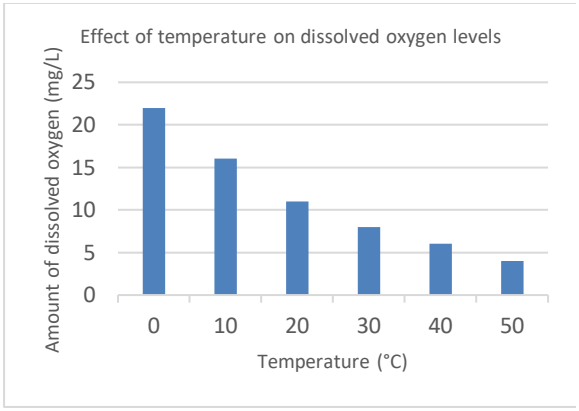
(B)



(C)



(D)



4. Students in a Science class were making a summary from their textbooks. Their teacher was collecting glassware from the back of the laboratory and placed these on a heavily laden tray. The teacher then took the items into the prep room. A loud "crash" was heard a few seconds later. One student said to the class, "Teacher had too much stuff on the tray to carry safely."

Identify the response that most closely describes scenes from this situation.

	Occurrence and description	
	A loud crash was heard.	***"Teacher had too much stuff on the tray to carry safely."***
(A)	Observation	Hypothesis
(B)	Observation	Observation
(C)	Secondary data	Interpretation
(D)	Investigation	Conclusion

5. Which of the following most closely resembles the hypothesis put forward by Marshall and Warren in the early 1980s?

(A) The causes of peptic ulcers do not follow Koch's postulates.

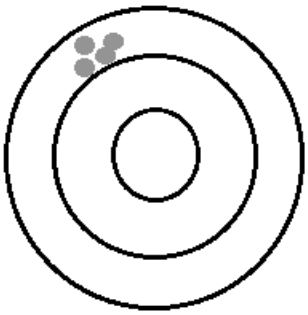
(B) Bacteria do not grow in the human stomach.

(C) Peptic ulcers were mainly caused by poor diet.

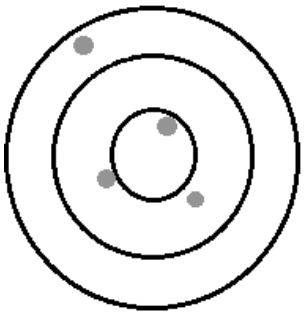
(D) *H. pylori* are a cause of peptic ulcers.

6. Which diagram below shows high precision and low accuracy?

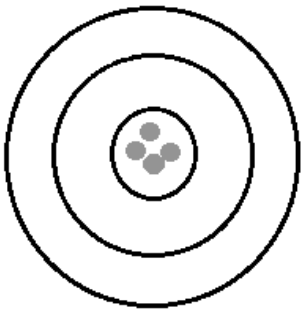
(A)



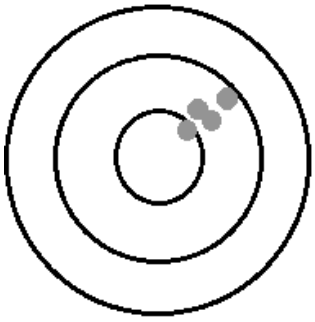
(B)



(C)



(D)



7. Which of the following is an example of a systematic error?

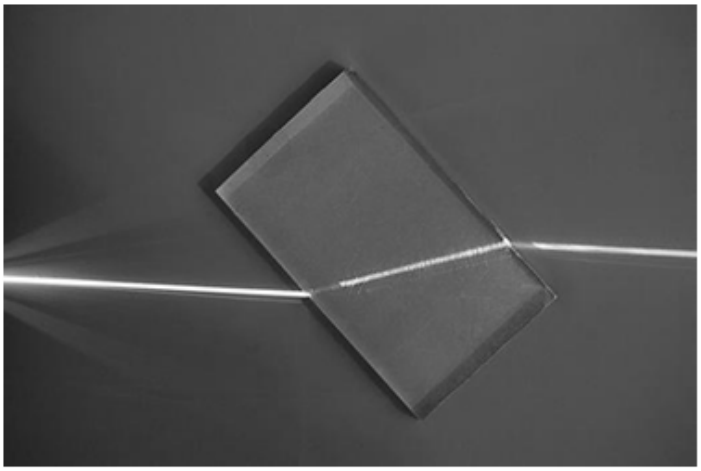
(A) A laboratory where the temperature changes slightly from hour to hour.

(B) Observing readings on a measuring cylinder from slightly different angles.

(C) The length of a measurement falling between two marks on a ruler.

(D) Recording masses on a balance without first ensuring the reading on the scale is zero.

8. The image below demonstrates a phenomenon utilised in various technologies



This phenomenon is critical to a technology utilised in which discovery?

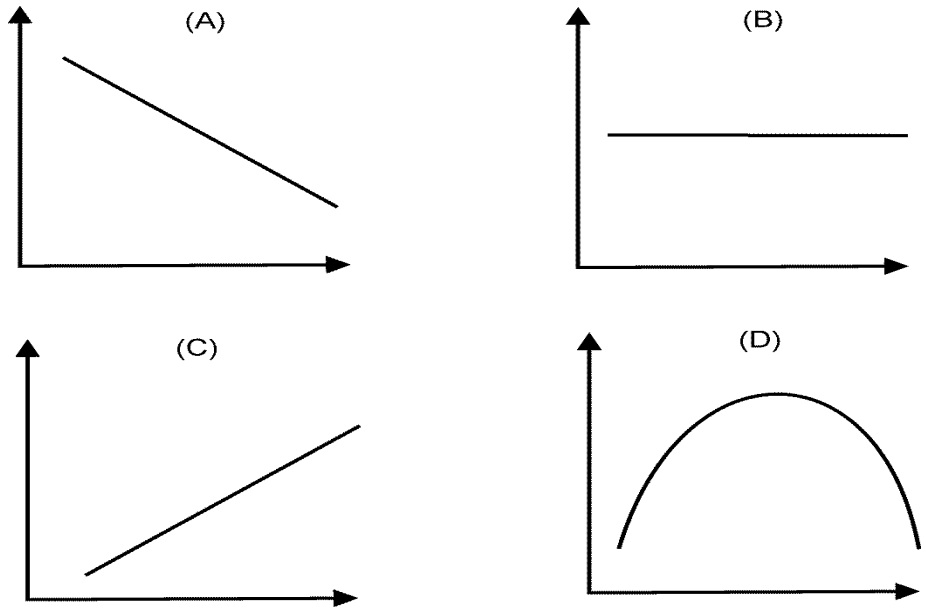
(A) The development of radiotherapy.

(B) Earthquake resistance in buildings.

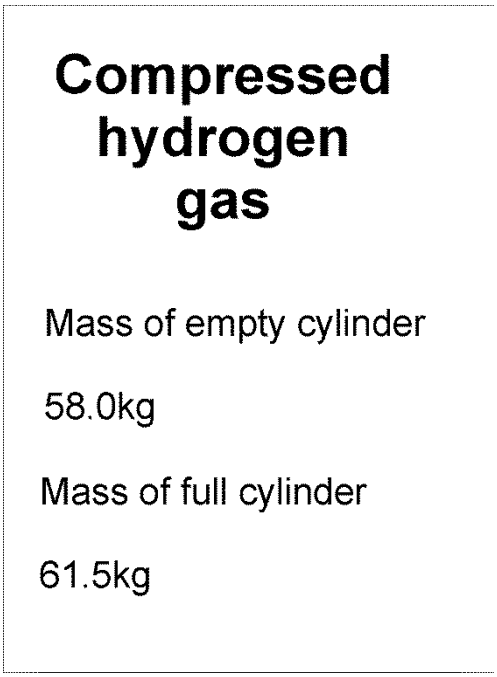
(C) The Higgs Boson.

(D) The moons around Jupiter.

9. Which of the graphs below shows the relationship between temperature (x-axis) and volume (y-axis) for a fixed mass of gas at a constant pressure?



10. Hydrogen is a gas which can be stored in steel cylinders. It can be sold by mass. Look at the label below on a particular cylinder of hydrogen.



The manufacturer guarantees that the actual mass of the contents is within plus or minus five percent (+/- 5%) of the value calculated from the details on the label.

What answer would be the closest to the expected mass of the contents?

(A) 350g

(B) 3150g

(C) 3340g

(D) 3800g

11. Which scientist's observation of a melting chocolate bar led to the invention of the microwave?

(A) Percy Spencer

(B) Robin Warren

(C) Jane Goodall

(D) Joseph Priestly

12. Which is the correct formula for the relationship between speed (v), distance (s) and time (t)?

(A) $v = \frac{s}{t}$

(B) $s = \frac{v}{t}$

(C) $v = s \times t$

(D) $t = s \times v$

13. In 1991 a study by Stampfer and Colditz linked hormone replacement therapy (HRT) to coronary heart disease. Which description of the study is correct?

(A) This study was found to be fraudulent.

(B) Its findings are still considered correct.

(C) It was an example of correlation being misinterpreted as causation.

(D) It was an example of causation being misinterpreted as correlation.

14. Firms will often have their logo or name on a football club's jersey to advertise their brand.



What is this an example of?

(A) The halo effect.

(B) The Hawthorn effect.

(C) The Mozart effect.

(D) The Bernoulli effect.

15. What statement about iridology is correct?

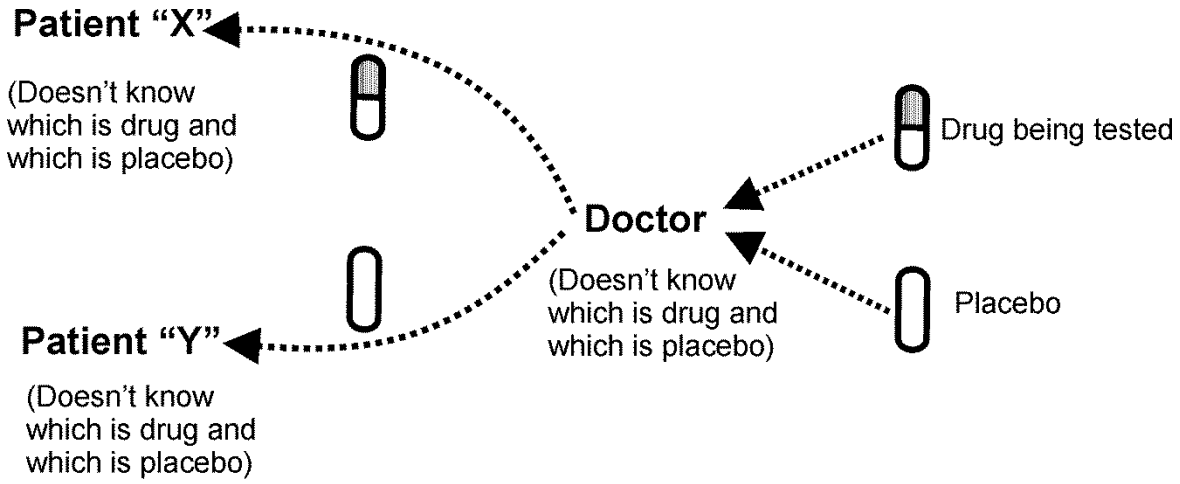
(A) It involves pricking the skin or tissues with needles.

(B) It uses very diluted solutions as medicines.

(C) It is an accepted mainstream medical science.

(D) Is regarded as a "pseudo-science" by most doctors.

16.



What is represented in the diagram?

(A) A linear model.

(B) A double-blind trial.

(C) A way to minimise infection of patients.

(D) A secondary-sourced investigation.

17. When doing research in a particular field, it is important that any material you study undergoes a "peer review" process. The following are the steps for a successful publication of a study but are not in the correct order.

Select the response that shows the correct order.

P The journal's editors send the article to other scientists who work in the same field.
Q A group of scientists completes a study and writes it up in the form of an article.
R Those reviewers provide feedback on the article.
S The study is published.
T The scientists submit it to a journal for publication.
U The authors may then revise their article and resubmit it for consideration.

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(A) Q, U, R, P, S, T

(B) Q, U, R, P, T, S

(C) Q, T, P, R, U, S

(D) Q, T, U, R, P, S

18. The data in the table shows the number of reported cases of measles in 2018 in four European countries.

Country	**France**	**Russian Federation**	**Ukraine**	**United Kingdom**
Cases of measles	2193	2256	53218	953
Population (millions)	67.2	144.5	44.83	66

Which is the only statement supported by the data?

(A) France has more than twice as many cases of measles per capita than the Russian Federation.

(B) People in the United Kingdom tend not to report cases of the measles.

(C) The strains of measles in Ukraine are more infectious than in other countries.

(D) The climate of a country plays a part in the incidence of measles.

19. The following table outlines the rate at which energy is consumed during various activities. One unit that is used is kilojoules per kilogram per hour.

Type of activity	Energy consumption rate (kJ/kg/hr)
Reading	2.1
Quick walk	16.3
Running	31.8

A runner with a mass of 80kg runs for 15 minutes.

What would be the total amount of energy used by the runner, in kJ?

(A) 38160

(B) 169.6

(C) 636

(D) 5.96

20. **The seeds of the** Gumbi Gumbi (*Pittosporum angustifolium)*, mulga (*Acacia aneura*), and the coolabah tree (*Eucalyptus microtheca*) have been used as traditional medicines by Aboriginal people for many years.

A researcher was comparing the relative solubility of these seeds. Part of the procedure is set out below:

- Collect seeds of the three plants.
- Weigh out as closely as you can 5.00g of each type of seed.
- Make a note of actual mass.
- Crush seeds in a mortar and pestle.
- Place crushed seeds in separate 250mL beakers.
- Add 150mL of water to each beaker.
- Stir and bring each to the boil for five minutes.
- Allow to cool.
- Weigh three pieces of filter paper.
- Filter mixture and retain filtrate on filter paper.
- Allow filter paper and filtrate to dry.
- Reweigh filter paper and filtrate.
- Calculate mass of seed "lost".
- Calculate percentage of seed that has dissolved in water.

Select the response that correctly identifies the types of variables.

	Controlled variable	**Dependent variable**	**Independent variable**
(A)	Initial mass of seed	Type of seed	Initial mass of seed
(B)	Volume of water	Percentage of seed that dissolves	Type of seed
(C)	Volume of water	Type of seed	Percentage of seed that dissolves
(D)	Percentage of seed that dissolves	Initial mass of seed	Type of seed

End of Section I

Investigating Science

Section II
Answer Booklet

80 marks
Attempt Questions 21–32
Allow about 2 hours and 25 minutes for this section

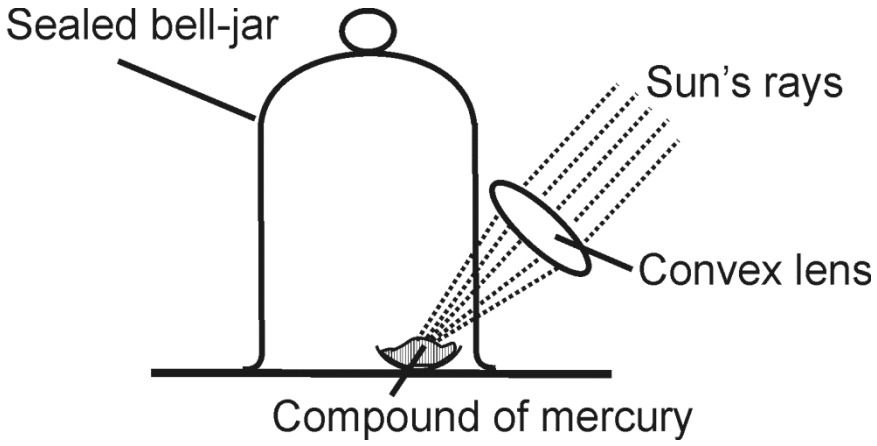
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Instructions

- 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 (5 marks)

Joseph Priestley conducted a series of experiments in the early 1770's, using various gases and organisms in bell jars.

(a) The diagram shows a simplified version of one of his experiments.



What was the outcome of this investigation? **1**

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(b) In another investigation Priestley placed a lit candle in a sealed bell jar full of air and noticed that the candle eventually went out. After this, the candle could not be relit while still in the jar. Give a conclusion that can be drawn from this observation. **1**

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Question 21 is continued over page

Question 21 continued

(c) Priestley continued his investigations. He then placed a growing green plant into a bell jar with a burning candle. The candle went out as before. However, when he waited several days and tried again, the candle could be relit. Priestley also placed a live mouse inside a sealed bell jar and it eventually collapsed and died. He found that if a growing green plant was placed in a sealed bell jar containing a mouse, the mouse lived for a longer time.

(i) Give a hypothesis for this sequence of experiments. **1**

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(iii) Assess the ethics of conducting this sequence of experiments. **2**

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Question 22 (7 marks)

A student was working on a project in class wearing ear buds and listening to music. When asked to remove the ear buds, the student said, "But I work better when I'm listening to music!" Some students agreed and others disagreed. The teacher allowed them to bring in their personal media players into the next lesson. The students played some tracks at the volume they thought was reasonable. The teacher was horrified at the loudness and type of the music and stated, "*Can anyone work properly with that sort of racket going on!*"

(a) Give an aim for this situation. **1**

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(b) Describe an experiment to test this hypothesis. In your answer you should describe the measures used to ensure that the investigation was valid. **6**

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Question 23 (3 marks)

Part of the Scientific method is that ideas are tested by scientists other than the person who first proposed the idea. One example of this happened in 1845 by the Dutch scientist Christoph Hendrik Diederik Buys Ballot (1817–1890). He organised a railway locomotive pulling an open cart. He assembled a group of trumpet players to play a single, steady note on the cart as it was pulled along the railway track. Ballot (and other observers) listened carefully to the note as the players approached and then went further away.

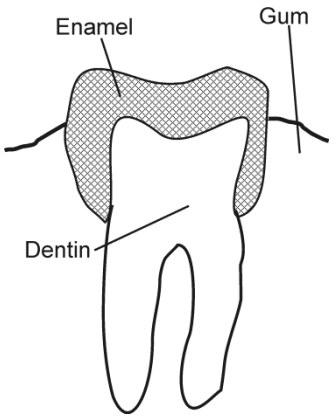
(a) Name the effect observed. **1**

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(b) Describe what Ballot would have heard. **2**

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Question 24 (7 marks)



Students researched the causes of tooth decay and came up with a simplified diagram of the structure of a tooth. According to their research, dentin dissolves below a pH of 6.50 and enamel dissolves below a pH of 5.50. Soft drinks were often blamed for tooth decay.

Two groups of students decided to test the pH of a variety of drinks sold in the school canteen. Group A used **universal indicator paper**, while Group B used a **digital pH meter**. Their results are shown below.

	pH of beverages sold in the canteen				
	Cola	**Sports Drink**	**Iced Tea**	**Chocolate Milk**	**Orange Juice**
Group A	2	3	4	7	3
Group B	2.53	2.95	4.50	6.60	3.25

a) Propose an aim for the students' investigation. **1**

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b) Describe one way the validity of this investigation would be ensured. **2**

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Question 24 continues over page

Question 24 continued

c) Universal indicator paper is an analogue technology whereas the pH meter was digital. Using this, or another appropriate named example, compare the accuracy of analogue and digital technologies in making observations. **4**

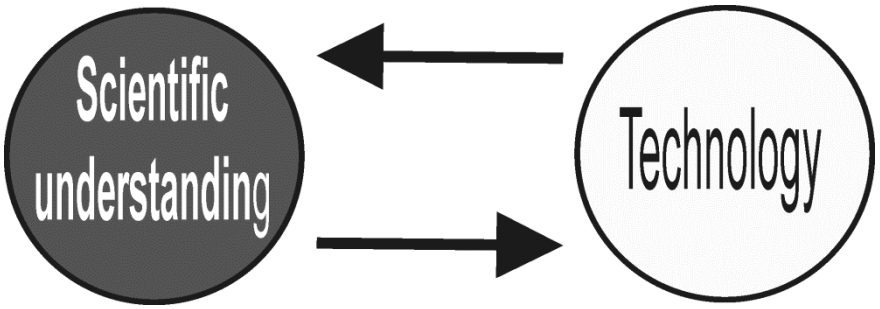
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Question 25 (10 marks)

a) Discuss the importance of x-ray diffraction in the discovery of the structure of deoxyribonucleic acid (DNA). **4**

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b) Using a different example than part a, assess the cyclical relationship between technology and scientific understanding. **6**



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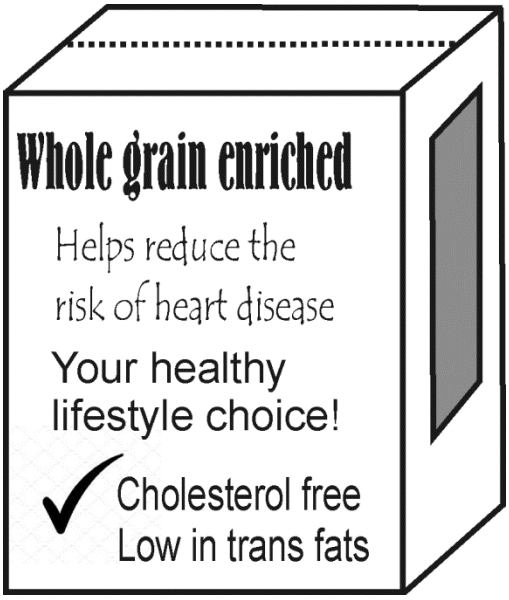
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Question 26 (9 marks)

In this course you investigated the effect of changes in temperature on reaction rate. Outline the experiment you conducted. Clearly identify the independent, dependent and control variables, as well as the technology used to collect quantitative data. **9**

Question 27 (5 marks)

Many foods make health claims on their packaging. Using the statements listed on the container shown (and/or other suitable examples) compare emotive advertising with evidence-based claims. **5**



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Question 28 (6 marks)

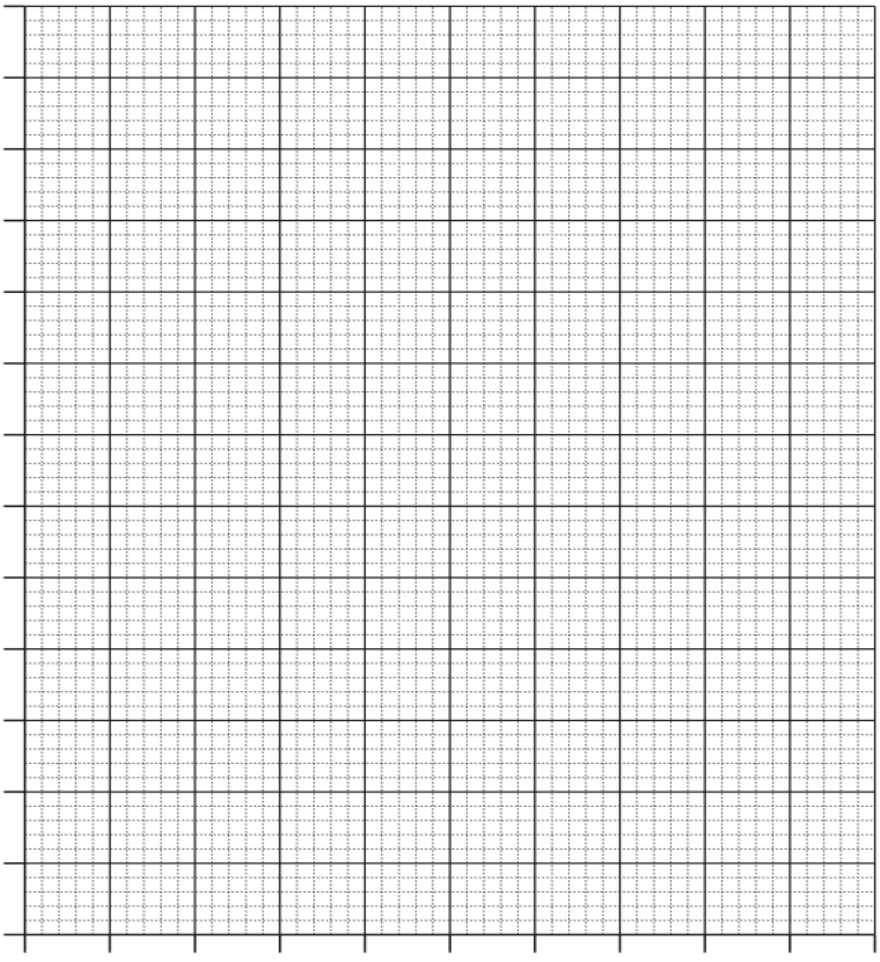
You have examined the process involved in the publishing of scientific papers, the threats to the process, as well as public perception of science. Evaluate the statement that "*science is a self-correcting discipline*". Use a specific example of fraudulent science to support your answer. **6**

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Question 29 (6 marks)

(a) Use the data table below to construct a graph of the effect of temperature on gas volume. **4**

Temperature (°C)	*Volume of gas* (mL)
0	49
15	55
30	57
45	60
60	70
75	77
90	80
105	83
120	86



Question 29 continues over page.

Question 29 continued.

(b) Summarise the trend seen in the graph. **1**

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(c) Predict the volume of the gas if the temperature is 150^{o} C. Illustrate how you came to your conclusion on your graph. **1**

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Question 30 (4 marks)

Using an example, explain how changing the sample size in a study can increase the reliability of an investigation. **4**

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Question 31 (8 marks)

Some screenshots from an advertisement for a popular body spray are shown below.





The following is from the company website:

About The Product:

Dreams really do come true with Lynx Ice Chill- instantly cooling, lowering skin temperature by 6 degrees, so you stay chill when it matters.

(a) Identify a claim you could test from this advertisement. **1**

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(b) Explain why consumers should question the claims made by this advertisement. Include two questionable features of this advertisement in your answer. **3**

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Question 31 continues over page.

Question 31 continued.

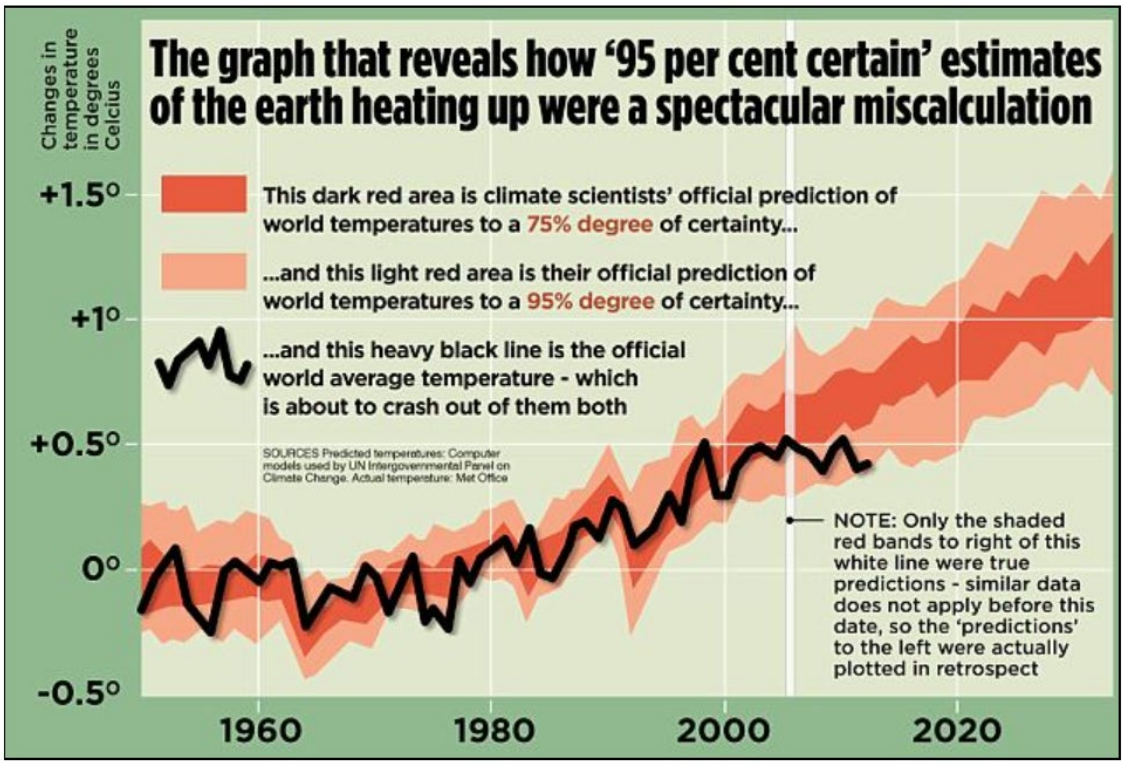
(c) The manufacturer of a similar body spray claims the spray contains a special chemical that attracts the opposite sex. A group of scientists has decided to test the claim of the manufacturer. Explain how this claim could be tested as a double blind, placebo-controlled investigation. **4**

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Question 32 (10 marks)

The science and data underpinning the theory that humans are contributing to changing climate and rising global temperatures is subject to intense scrutiny by sections of the media.

The following is an infographic that was published by the Mail on Sunday, a British newspaper.



(Source and image credit: Mail on Sunday)

The newspaper's *underlying conclusion* in the article was that, on the basis of the data in the graph, there is no evidence of climate change.

(a) According to the modelled data, what was the UPPER estimate for the rise in temperature predicted in the year 2010 with a 95% certainty? **1**

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Question 32 continues over page.

Question 32 continued.

(b) Outline what is represented by the darker red shaded area of the graph. **1**

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(c) The following are excerpts explaining how global temperature data is gathered and its underlying significance.

To get a complete picture of Earth's temperature, scientists combine measurements from the air above land and the ocean surface using ships, buoys and sometimes satellites.

The temperature at each land and ocean station is compared daily to what is 'normal' for that location and time, typically the long-term average over a 30-year period. The differences are called 'anomalies' and they help scientists evaluate how temperature is changing over time.

A 'positive' anomaly means the temperature is warmer than the long-term average, a 'negative' anomaly means it's cooler.

(Source: Explainer: How do scientists measure global temperature? Retrieved from https://www.carbonbrief.org/explainer-how-do-scien tists-measure-global-temperature)

The global temperature record represents an average over the entire surface of the planet. The temperatures we experience locally and in short periods can fluctuate significantly due to predictable cyclical events (night and day, summer and winter) and hard-to-predict wind and precipitation patterns. But the global temperature mainly depends on how much energy the planet receives from the Sun and how much it radiates back into space—quantities that change very little. The amount of energy radiated by the Earth depends significantly on the chemical composition of the atmosphere, particularly the amount of heat-trapping greenhouse gases.

(Source: World of change: Global temperatures. https://earthobservatory.nasa.gov/world-of-change/DecadalTemp)

Question 32 continues over page.

Question 32 continued.

With reference to both the graph on the previous page and the excerpts above, critically evaluate the *underlying conclusion* drawn by the Mail on Sunday. **8**

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

Section II extra writing space

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

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Student Number:……..

INVESTIGATING SCIENCE – 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 ⬭