NSW Education Standards Authority

2019 **HIGHER SCHOOL CERTIFICATE EXAMINATION**

Investigating Science

General Instructions

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

Total marks: 100

Section I – 20 marks (pages 2–12)

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

Section II – 80 marks (pages 13–28)

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

Section I

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

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

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1 A company was hired to analyse data collected from surveillance cameras in a workplace. The aim of the analysis was to see what factors distracted workers on an assembly line. The workers knew this study was being undertaken.

What would the researchers need to take into consideration when analysing this evidence?

A. The Halo effect

B. The Mozart effect

C. The Doppler effect

D. The Hawthorne effect

2 What method was used to confirm the existence of the Higgs boson?

A. Fieldwork

B. Conducting surveys

C. Data analysis from experiments

D. Locating and using information sources

3 In a peer-reviewed research paper, where would the information about the purpose of the research be found?

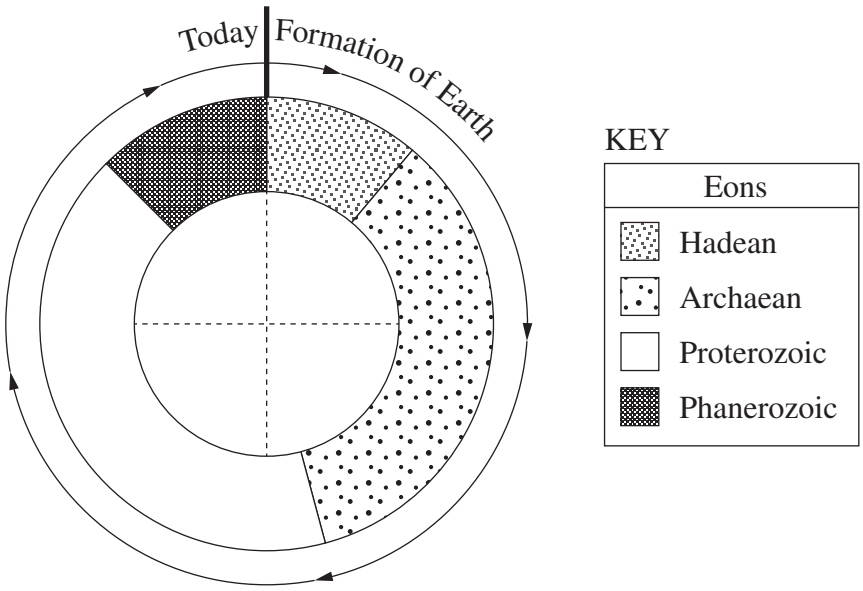
A. Abstract

B. Citations

C. Method

D. Results

4 Earth's geological history can be modelled on a chart. Earth is about 4500 million years old.



Approximately how long did the Archaean eon last?

A. 600 million years

B. 1500 million years

C. 2100 million years

D. 2400 million years

5 Which factor allowed the vaccine to be so successful in eradicating smallpox?

A. The vaccine could be given to dairy cows to create herd immunity.

B. Smallpox was not found globally so only small localised populations needed vaccination.

C. Smallpox was only found in human populations so there were no reinfections from other animals.

D. The vaccine protected immunised people from cowpox since vaccinated people developed antibodies to smallpox.

6 A student at home wished to remove nail polish from their fingernails but only had acetone available. The student consulted a safety data sheet.

acetone 1.7–3.5 M (10–20% wt/wt) (propanone)

Class: nc PG: none Users: 7–12 Training: 1–6

GHS data:

DANGER

Flammable liquid and vapour
Causes serious eye irritation

Potential hazards
Irritates eyes

Which is the best action the student could take to minimise the risk when using acetone as a nail polish remover at home?

A. Have running water available

B. Wear gloves and safety glasses

C. Use the acetone in a fume cupboard

D. Keep the acetone away from naked flames

7 An advertisement for a particular brand of toothpaste claimed that 80% of dentists recommend it. When the claim was investigated, it was found that a total of six dentists had been surveyed and, of these, one dentist became sick during the study so could not finish the questionnaire.

Which row of the table correctly identifies the conclusion made regarding sample size and the advertising claim?

	Sample size	*Advertising claim*
A.	Too small	Misleading
B.	Too small	Not misleading
C.	Sufficient	Misleading
D.	Sufficient	Not misleading

8 Five iridologists were shown photographs of the irises of 39 people with gallstones and 39 people without gallstones.

The iridologists were asked to identify, from the photographs alone, whether the people had gallstones or not.

Each iridologist successfully identified about half of the gallstone sufferers. However, each iridologist identified a different set of people as having gallstones.

What conclusion could be made about this investigation?

A. The results are consistent with random guessing by the iridologists.

B. The results show that iridologists can diagnose diseases by looking at the iris.

C. The results could be made more valid by increasing the number of iridologists.

D. The results could be made more reliable by increasing the number of photographs.

9 The following claims were found on the labels of a variety of food or healthcare products.

Which claim suggests that it is the result of evidence-based research?

A. Antioxidant-rich superfood

B. May improve blood circulation

C. Believed to improve oxygen delivery

D. Absorbed in half the time of standard aspirin

10 A well-known, popular and attractive movie actor was recently involved in a successful advertising campaign to sell a new smartphone.

What would have been the main reason for using this actor in the campaign?

A. The general public's perception of the actor would make the phone more desirable.

B. The actor would have been backed by peer-reviewed evidence from a research company.

C. The actor would have been able to speak authoritatively to the general public on the merits of this phone.

D. The general public's perception of the actor would allow them to make a more informed choice of phone.

11 Eratosthenes successfully determined the circumference of Earth. He measured the length of the shadow cast by a rod in Alexandria on the day when the sun was directly overhead in Syene and cast no shadows.

What assumption was required for Eratosthenes to calculate the circumference of Earth?

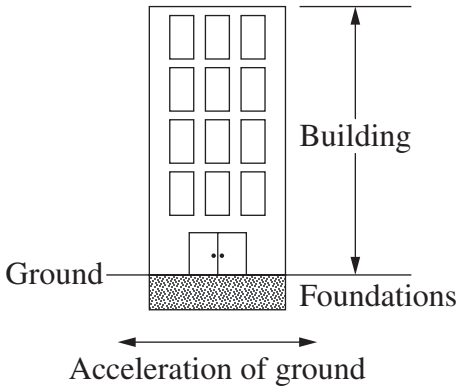
A. Alexandria and Syene are at different heights above sea level.

B. Alexandria and Syene are the same distance north of the equator.

C. The sun is so far away that radiation reaches Earth in parallel rays.

D. The measurements were taken when the shadows had minimum length.

12 Earthquake P-waves cause the ground to accelerate parallel to the direction in which the earthquake waves are travelling.



Why can this type of earthquake wave cause the building shown to collapse?

A. The building's inertia prevents it from moving.

B. The building is not designed to withstand vertical forces.

C. The building accelerates in the same direction as the earthquake wave.

D. Sudden horizontal acceleration of the building shears it from its foundations.

13 A study was conducted to determine whether a new drug for the treatment of prostate cancer was effective in humans. The scientists searched thousands of manufacturers' databases for trials of the drug that were conducted in 2018.

Of 1361 trials from three different countries, seven were selected because they were controlled in-vitro (cell cultures in a test tube) trials that compared the new treatment with others currently available.

Which statement correctly explains the effectiveness of this study?

A. It was a well-conducted study, since it used more than 1000 trials from more than one country, providing reliable data.

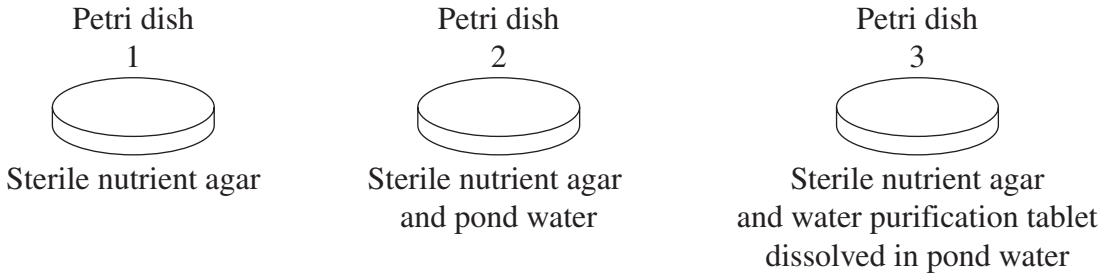
B. It was a poor study, since the experiments did not use random samples and were conducted in-vitro which may have differing results from in-vivo (in the body) trials.

C. It was a poor study, since there were no placebo studies, and the experiments were conducted in 2018, so the data may no longer be up to date.

D. It was a well-conducted study, since the scientists used the large databases of information from the manufacturers to allow a meta-analysis of the data to be conducted.

14 Colonies of bacteria are visible when grown on nutrient agar in a Petri dish.

An experiment was to be carried out to determine whether water purification tablets were effective in killing bacteria in pond water.



Which Petri dish(es) are required as a minimum to establish the effectiveness of the water purification tablets?

A. 3

B. 1 and 3

C. 2 and 3

D. 1, 2 and 3

15 A herbicide called dicamba is highly effective in killing plants. A company that makes dicamba has also developed a genetically modified (GM) cotton variety that is not killed by dicamba.

The GM cotton seeds are popular because they boost crop yields, improving the farmers' profits. The company's GM seeds are more expensive than other varieties and this increases profits for shareholders.

However, the use of the herbicide dicamba is controversial because it can drift from the sprayed areas into neigbouring farms, killing other crops. Some farmers are being forced to buy the new GM seeds to guard against damage caused by dicamba being used on neighbouring farms.

To best meet the interests of all the farmers, the GM seed company and its shareholders, laws should be enacted that

A. ban the use of dicamba.

B. ban the use of this GM cotton crop.

C. require farmers to leave areas near their neighbours unsprayed.

D. require farmers to submit an application for an ethics review before they use GM crops.

16 A one-metre plastic ruler was calibrated during its manufacture to produce accurate readings at 20°C.

The lengths of three objects were measured with this plastic ruler at 20°C.

The lengths were 10.0 cm, 20.0 cm and 80.0 cm respectively.

The temperature was increased, which caused the ruler to expand in length by 10 mm. However, the length of the three objects did not increase.

The objects were then measured again.

Which row in the table shows the three new measurements of the objects?

	Object 1 (cm)	*Object 2* (cm)	*Object 3* (cm)
A.	9.9	19.8	79.2
B.	9.9	19.9	79.9
C.	10.1	20.1	80.1
D.	10.1	20.2	80.8

17 A low-joule sweetener called Low-J can be used as a sugar replacement for sweetening drinks and food products.

Two hundred people of different ages participated in an experiment.

Equal volumes of milk were separately sweetened using sugar in one and Low-J in the other. The mixtures were of equal sweetness.

Two hundred 50 mL cups of each prepared mixture were measured out and uniquely marked with a code known only to the experimenter.

An assistant randomly chose two cups from the 400 prepared ones and gave these to each participant who was asked to taste them and tell the assistant if they tasted the same or not. The assistant recorded the response as well as the code on each cup.

The purpose of the experiment was to determine whether

A. people were likely to be influenced by a placebo.

B. people's ability to identify the taste of Low-J was related to their ages.

C. people could taste a difference between the two samples they were given.

D. people could identify the samples that had been sweetened using Low-J rather than sugar.

18 A student was conducting an investigation to determine which one of four scientists was having the greatest impact in their field of scientific research.

	Number of years conducting research in science	*Total number of peer reviewed scientific papers*	*Total number of citations*	*i10-index* (number of papers with at least 10 citations)
Scientist 1	8	150	2751	53
Scientist 2	9	168	2761	75
Scientist 3	22	97	2759	42
Scientist 4	42	173	2762	26

The student examined the data and made the following inferences.

Which inference is correct?

A. Scientist 1 has published approximately 19 papers per year, but has only been in research for 8 years, so this scientist's research must be fairly basic, and thus must be having the least impact.

B. Scientist 2 has published approximately 19 papers per year, has the highest i10-index and nearly the highest number of citations, so this scientist's research must be having the greatest impact.

C. Scientist 3 has only published approximately 4 papers per year, which is the lowest number of papers published, so this scientist must be having the least impact.

D. Scientist 4 has only published approximately 4 papers per year, but has had both the highest number of papers and the highest number of citations, so this scientist's research must be having the greatest impact.

19 An app on a smartphone produces a spectrogram of a sound source which shows the frequencies present in sound and how these vary over time.

A source of sound having a fixed frequency analysed using this app produced the result shown in Figure 1. The same source of sound produced the result shown in Figure 2 when it was moving relative to the smartphone.

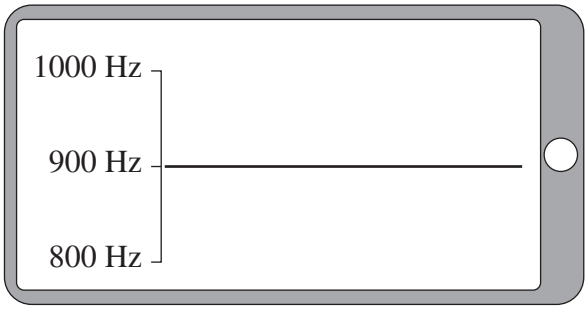


Figure 1

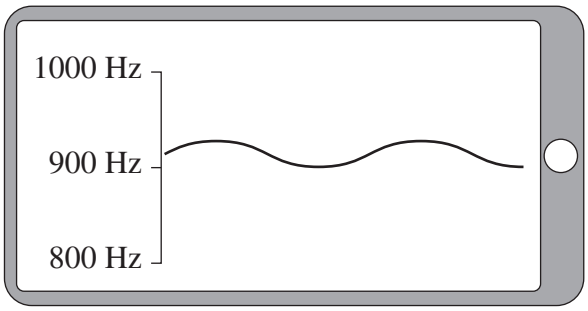


Figure 2

Which statement describing the movement of the sound source is consistent with the results shown in Figure 2?

A. The sound source is moving directly towards the smartphone and the sound has increased in loudness.

B. The sound source is moving directly away from the smartphone and the sound source has increased in frequency.

C. The sound source is moving directly away from the smartphone and it is oscillating along a line perpendicular to this movement.

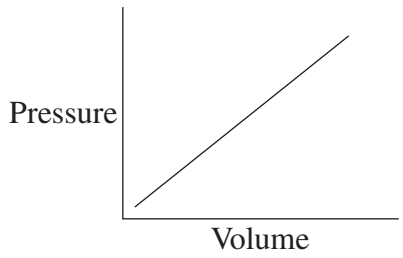
D. The sound source is moving directly towards the smartphone and it is rotating in a vertical circular path which has a plane parallel to the direction of motion.

20 A student compressed a sample of gas by pushing on the end of a sealed syringe.

A pressure sensor was used to measure the gas pressure in the syringe. The volume of the gas sample was measured using the scale on the syringe.

Which graph is consistent with the student's hypothesis that pressure × volume of a gas is a constant?

A.



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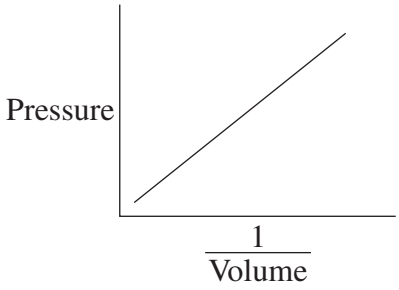

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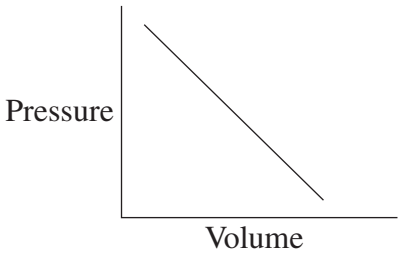
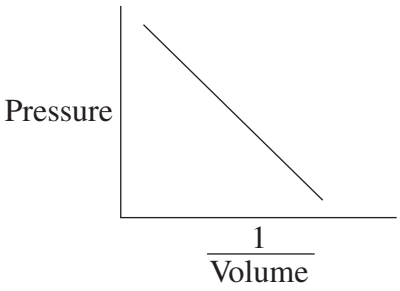


D.



2019 HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Student Number

Investigating Science

Section II Answer Booklet

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

Instructions

- Write your Centre Number and Student Number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.

Please turn over

Question 21 (6 marks)

Barry Marshall and Robin Warren were involved in investigating the cause of peptic ulcers.

(a) Outline an observation that led Marshall and Warren to study peptic ulcers. **2**

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(b) Outline the steps taken by Marshall and Warren to establish the cause of peptic ulcers. **4**

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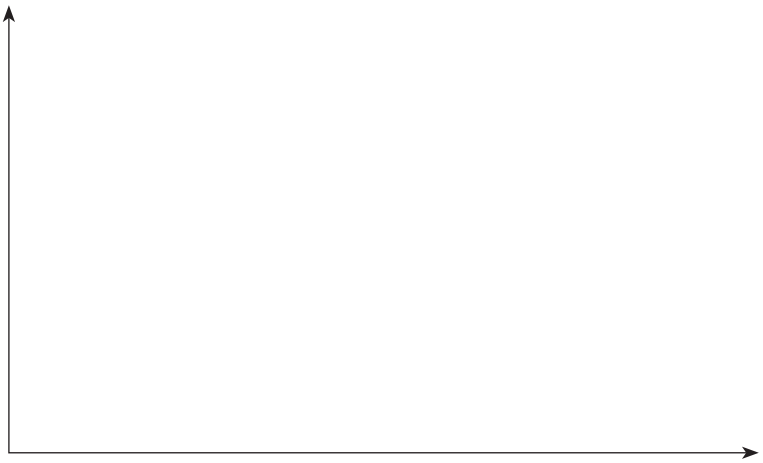
Question 22 (4 marks)

Students were investigating the effect of speed on the distance travelled by a car. They measured the distance the car travelled at a constant speed. The experiment was repeated for a variety of other constant speeds.

(a) Sketch a graph on the axes provided to indicate the expected results. **2**



(b) Identify another variable that determines the distance the car travels and explain why this variable must be kept constant in the investigation. **2**

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Question 23 (6 marks)

Design a valid method to safely investigate the hypothesis: 'increasing the temperature increases the rate of a chemical reaction'. **6**

In your answer, include how you would calculate the rate of reaction.

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Question 24 (7 marks)

A researcher wanted to investigate the effect of distraction on the number of errors made by drivers. The researcher chose two students.

The first student used a racing car simulation game and played for five uninterrupted minutes. The number of driving errors was recorded.

The second student played the same racing car simulation game for five minutes, but was asked to send a short (10-word) text message every minute using their mobile phone, while driving. The number of driving errors was recorded.

(a) Propose a hypothesis for this experiment. **1**

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(b) Identify TWO problems with this experimental method AND explain why each is a problem. **3**

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(c) Evaluate the relevance of this method to the effect that the researcher wanted to investigate. **3**

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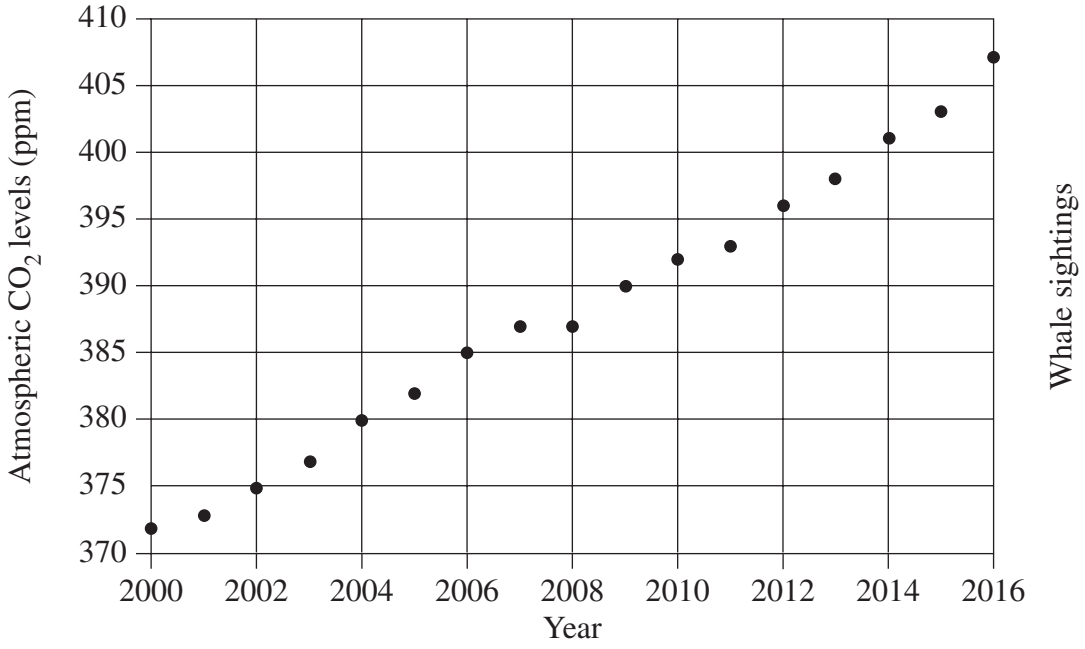
Question 25 (9 marks)

The table shows approximate numbers of whale sightings from a coastal location from 2000–2016.

Year	2000	2002	2004	2006	2008	2010	2012	2014	2016
Whale sightings	400	950	1100	1650	1500	1800	1700	2700	3050

The graph shows atmospheric carbon dioxide levels at the same location over the same period.



(a) On the grid above, use a ruler to draw a straight line of best fit for the atmospheric carbon dioxide. **1**

(b) On the grid above, create an appropriate scale on the right-hand axis AND plot the number of whale sightings over this period. Use the symbol × to plot your data points. **2**

Question 25 continues on page 19

Question 25 (continued)

(c) What inference could be drawn from this graph? Use data from the graph to justify your answer. **2**

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(d) Using a different example, explain how evidence of a correlation can be misinterpreted as causation. **4**

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End of Question 25

Question 26 (3 marks)

In the 17th century, Jan Baptist van Helmont conducted a significant, but flawed, experiment into the relationship between water and a tree's growth. **3**

With reference to current knowledge of plant growth, identify the flaw and describe a modification that could be made by present-day scientists to correct the flaw in van Helmont's experiment.

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Question 27 (4 marks)

Aboriginal and Torres Strait Islander Peoples have known and understood the medicinal value of plants for thousands of years.

(a) Outline a specific medicinal use of an identified plant used by Aboriginal or Torres Strait Islander Peoples. **2**

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(b) Outline the potential of a different Australian plant from Country and Place that could be used in the development of a new drug treatment. **2**

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Please turn over

Question 28 (7 marks)

Discuss TWO types of misuse of scientific evidence by the tobacco industry in relation to lung cancer. Support your answer with an example of each type of misuse. **7**

Question 29 (5 marks)

(a) What is the main requirement in selecting a person to carry out a peer review of a scientific paper intended for publication? **1**

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(b) How is science advanced by having peer reviews of scientific papers? Include an example to support your answer. **4**

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Question 30 (6 marks)

Projects to dam rivers both in Australia and overseas have influenced the way science is perceived by the public.

(a) Complete the table in relation to a relevant case study. **2**

Name of river:	
Positive aspect of damming	*Negative aspect of damming*

(b) Analyse the effect that ONE project to dam a river had on the public image of science. **4**

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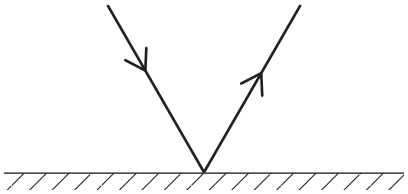
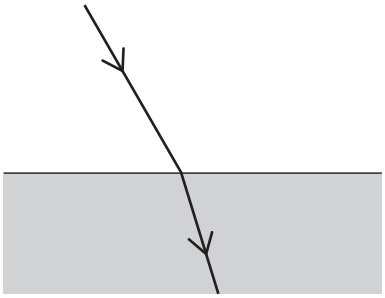
Question 31 (4 marks)

The diagrams show two phenomena associated with waves. **4**

Phenomenon *A*



Phenomenon *B*



Identify each of the illustrated phenomena and describe how each has been applied in developing new technologies in telescopes.

Phenomenon *A* ..... Phenomenon *B* .....

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Question 32 (6 marks)

Medical surgical devices can affect human health both negatively and positively. **6**

Evaluate the impacts of ONE specific medical surgical device on human health. In your answer, refer to applications of the device.

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Question 33 (6 marks)

(a) Explain, using an example, ONE ethical issue that may arise in relation to current scientific research. **3**

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(b) Evaluate the effectiveness of ONE protocol or code of conduct that is in place to ensure that scientific research or practice is carried out ethically. **3**

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Please turn over

Question 34 (7 marks)

Analyse the impact that both government and large corporations have on scientific research. Include examples, other than from the tobacco industry, to support your answer. **7**

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