Student Name

Student Number

Sydney Secondary College Blackwattle Bay

2020

Trial Higher School Certificate Examination

Investigating Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Diagrams in pencil
- NESA approved calculators may be used
- Write your student number at the top of every page
- Write your name in the space provided
- Extra writing space can be found at the end of Section II on pages 30 and 31

Total Marks - /100

Section I Pages 3-8
Total Marks (20)
Attempt Questions 1-20
Allow about 35 minutes for this section

Section II Pages 11-29
Total Marks (80)
Attempt Questions 21 - 34
Allow about 2 hours and 25 minutes for this section

Student Name

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Section I – 20 marks

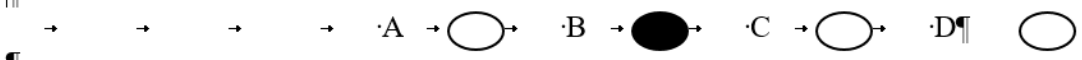
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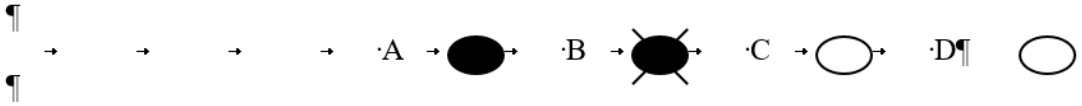
Use the multiple-choice answer sheet.

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

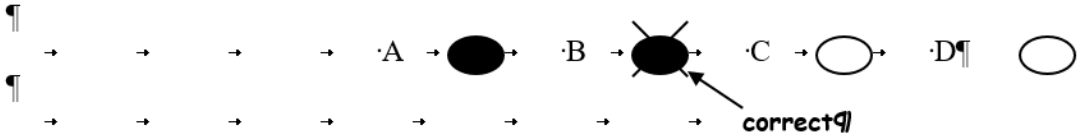
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1 What condition would patients who developed peptic ulcers most likely have?

A. Poor diet
B. Stressful job
C. Bacterial infection
D. Family history of peptic ulcers

2 A teacher noticed a decline in the completion of work when students were not being supervised. When the teacher walked into the classroom and begun supervising the class, the classwork submission rate increased.

What is the name of this effect?

A. Mozart Effect
B. Doppler Effect
C. Bernoulli Effect
D. Hawthorne Effect

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What is this an example of?

A. Fieldwork
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Question 4 and 5 are based on the information below.

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Below is the table of results:

	Number of days for wheat seed to germinate		
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4 Which of the following correctly identifies the variables in this experiment?

	Independent variable	*Dependent variable*	*Controlled variable*
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A. The warmer the soil, the faster the seeds will germinate
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A. Live flu virus
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Investigating Science

Section II Answer Booklet

Section II – 80 marks
Attempt Questions
Allow about 2 hours and 25 minutes for this section.

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 on
pages 30 and 31.

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Student Name

Student Number

Question 21 (4 marks)

A student was investigating the hypothesis that paper planes with larger wings stay in the air longer than paper planes with smaller wings.

(a) Identify the independent and dependent variables. **2**

Independent variable:

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Dependent variable:

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(b) List any variables that would need to be controlled in order to design a valid experiment. **2**

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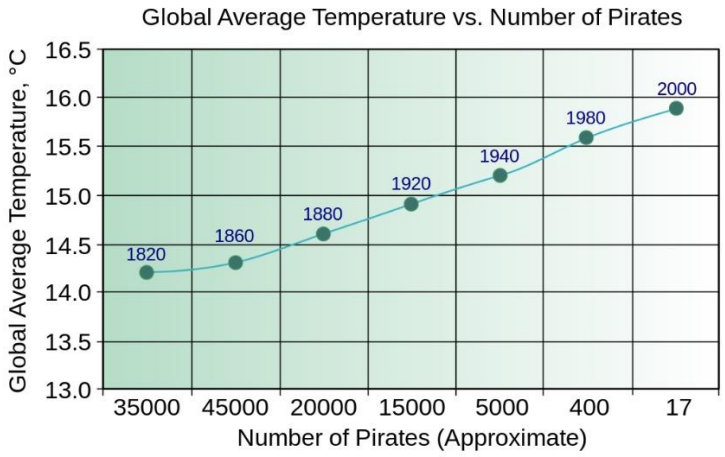
Student Name

Student Number

Question 22 (3 marks)

With reference to the graph shown, evaluate the statement: **3**

"Stop Global Warming – become a Pirate"



Student Name

Student Number

Question 23 (3 marks)

During the course, you investigated a scientist who falsified their scientific results.

Drawing on this example, discuss how the peer review process could have been used to uncover fraudulent research. **3**

Student Name

Student Number

Question 24 (9 marks)

Below is an extract from an SDS (Safety Data Sheet) on Hydrochloric acid.

2. HAZARDS IDENTIFICATION

Emergency Overview:	DANGER! Corrosive. Causes severe skin, eye, and digestive tract burns. Harmful if swallowed. Mist or vapor extremely irritating to eyes and respiratory tract.
	Safety Ratings: Health: 3, Severe; Flammability: 0, None; Reactivity: 1, Slight; Contact: 4, Extreme
OSHA Regulatory Status:	This product is considered a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
Potential Acute Health Effects:	
Routes of Exposure:	Inhalation, ingestion, skin contact, eye contact
Inhalation:	Corrosive. May cause damage to mucous membranes in nose, throat, lungs and bronchial system.
Ingestion:	Corrosive. Harmful if swallowed. May produce burns to the lips, oral cavity, upper airway, esophagus and digestive tract.
Skin Contact:	Corrosive. Causes severe burns.
Eye Contact:	Corrosive. Causes severe burns. Vapor or spray may cause eye damage, impaired sight or blindness.
Target Organs:	Skin, respiratory system, eyes, lungs
Chronic Health Effects:	Corrosive. Prolonged contact causes serious tissue damage.

A student wished to conduct an experiment to determine whether the temperature of hydrochloric acid influenced the rate of its reaction with a strip of magnesium metal.

(a) With reference to the SDS extract, describe TWO safety procedures that the student should follow when using hydrochloric acid. **2**

Question 24 continued on the next page

Student Name

Student Number

Question 24 (continued)

(b) Outline a valid, reliable and safe method that could be used to determine the relationship between the temperature of hydrochloric acid and its reaction rate with magnesium ribbon. **4**

(c) Describe a source of random error in your method, and suggest how the impact of this error could be minimised. **3**

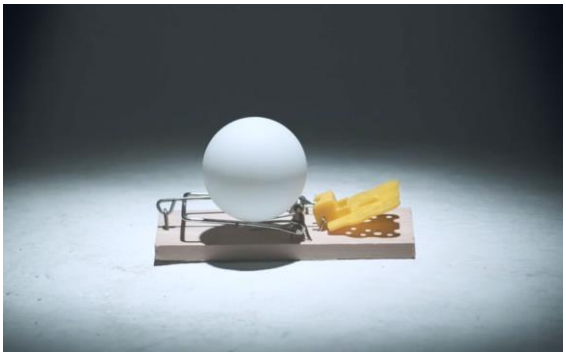
Student Name

Student Number

Question 25 (10 marks)

A student was studying the spread of disease and developed a model to investigate the relationship between organism distancing and the rate of spread of a disease.

The model involved loading mousetraps with ping pong balls and spacing them around an enclosed area with various spacing densities.



40 such mousetraps were loaded with TWO ping pong balls each and spaced at different densities, and the total amount of mousetraps that had been activated within a 30 second period was recorded.

The data that the student gathered was averaged and shown in the table below:

Mousetrap density (traps/unit area)	0	2	4	6	8	10	12	14	16
Number of traps activated in 30 seconds	0	1	4	8	15	24	36	39	40

(a) State the independent variable in this investigation. **1**

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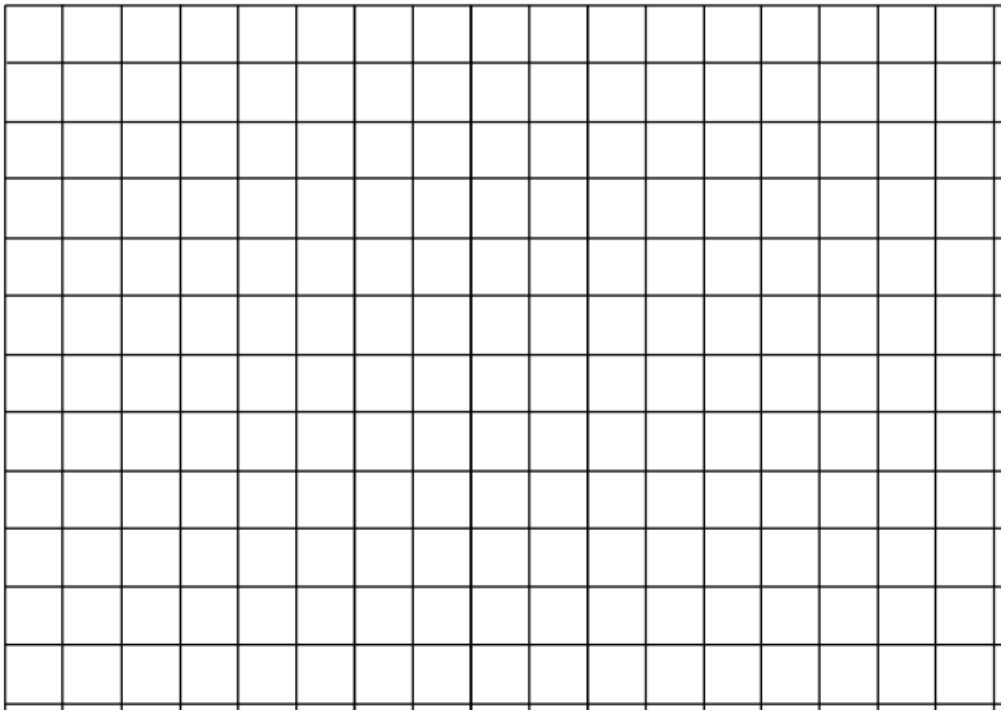
Question 25 continues on the next page

Student Name

Student Number

Question 25 (continued)

(b) Using the grid below, appropriately graph the data. **5**



(c) Describe the trend demonstrated by the data. **2**

(d) Explain what aspect of the study is being modelled by the ping pong balls. **2**

Student Name

Student Number

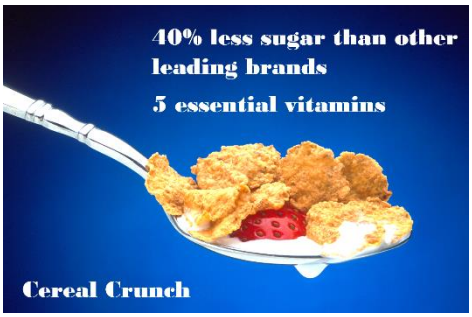
Question 26 (6 marks)

Two advertisements for breakfast cereals are shown below.

Crunchy Bites



Cereal Crunch



(a) Compare the advertising techniques of the two cereal companies, Crunchy Bites and Cereal Crunch. **3**

(b) Explain how these techniques could persuade consumers to purchase their brand of cereal. **3**

Student Name

Student Number

Question 27 (6 marks)

In July 2018, Australia founded the Australian Space Agency (ASA). The ASA would be responsible for coordinating and providing advice on the civil and space sector, as well as administering space activities legislation and delivering on our international obligations. In order to achieve this, the agency was given an annual budget of 9.8 million dollars.

Discuss the controversy surrounding funding for space exploration. **6**

Student Name

Student Number

Question 28 (3 marks)

Discuss how the development of flight has benefited society and affected the overall public perception of science. **3**

Student Name

Student Number

Question 29 (5 marks)

Iridology claims that colours, patterns, and various other properties of the iris can be used to assess an individual's general health. Iridology practitioners and followers believe that each organ in the human body has a corresponding region in the iris. Thus, the organ can be examined by inspecting the iris.

Analyse the above claim to discuss that identifying pseudoscience is important to maintain the integrity of Science. **5**

Student Name

Student Number

Question 30 (5 marks)

Science related events affect society's view of Science.

Use the Chernobyl nuclear meltdown of 1986 to discuss the effect of this incident on the public image of science. **5**

Student Name

Student Number

Question 31 (4 marks)

Approximately 300 million people died from the highly contagious disease, smallpox, during the 20th century. Despite being globally eradicated by 1980, samples of the virus are still held at two laboratories, one in America and one in Russia.

Evaluate the ethics of keeping these samples. **4**

Student Name

Student Number

Question 32 (7 marks)

Scientific investigations on humans can be affected by bias from both the participant and the researcher. Two ways in which research can reduce or eliminate this bias is by conducting 'single-blind trials' or 'double-blind trials.'

(a) Define the term blind trial and distinguish between a single-blind and a double-blind trial. **2**

(b) In August 2018, the FDA (US Food and Drug Administration) released a document suggesting investigators should stop using double blind clinical trials with placebo products when treating people who are suffering from an illness. **2**

Suggest a reason for this approach

Question 32 continued on the next page

Student Name

Student Number

Question 32 (continued)

(c) State the aim and outline a suitable method that could be used to conduct a double-blind trial to investigate the following question:

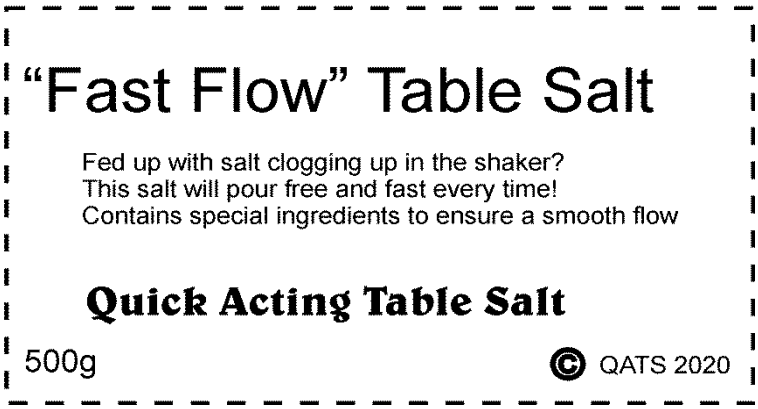
Can people tell the difference between brand name lemonade and generic supermarket lemonade? **3**

Student Name

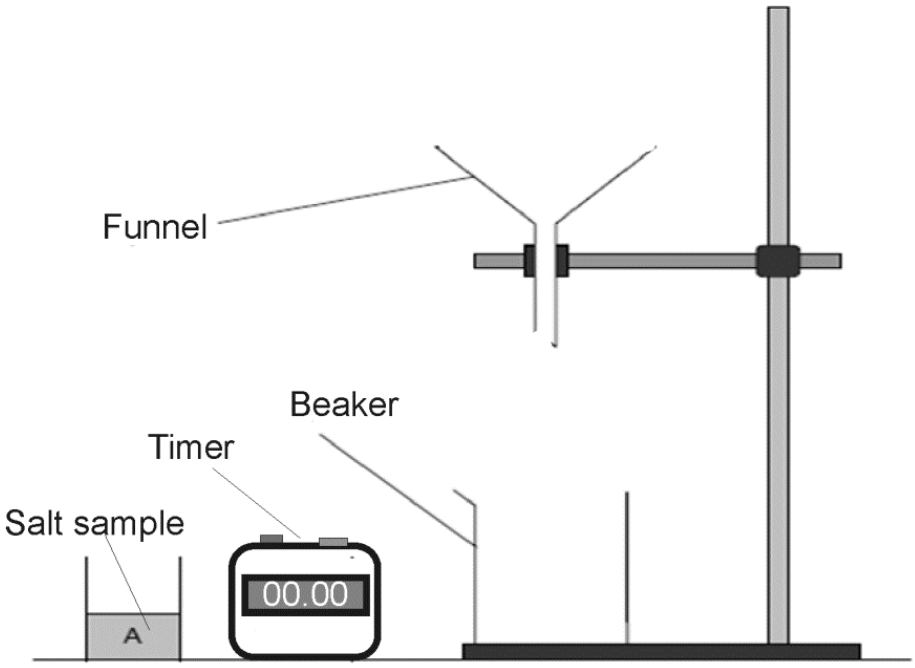
Student Number

Question 33 (11 marks)

A student became annoyed that whenever the salt shaker was used on food only a very small amount of salt came out because the holes became blocked. The student went out and bought a packet of salt, the label of which is shown below.



Despite the claim to "pour free and fast", the new product did not seem to be much better than the old one. The student decided to test the claims made on the label by comparing this salt with three other types using the apparatus shown below. This was set up in a school science laboratory as shown in the diagram.



Question 33 continued on next page

Student Name

Student Number

Question 33 (continued)

Part of the student's write up is shown below.

Method:

Three different types of salt were tested: the original brand, 'Fast flow" table salt and supermarket "own brand".

100g of the salt under test was weighed into a dry beaker. This was poured into the filter funnel and how long all of the salt took to pour into the lower beaker was timed.

This was repeated twice.

Results:

The original type of salt took: 12.5 seconds, 11.7 seconds and 12.1 seconds

Fast flow took: 21.7 seconds, 10.9 seconds and 11.8 seconds

"Own brand" took: 12.1 seconds, 12.4 seconds and 11.9 seconds.

(a) Draw a table with suitable headings containing the results and calculate the average time for each. **4**

(b) Comment on the validity, reliability and accuracy of the procedure used by the student. **3**

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Question 33 continued on the next page

Student Name

Student Number

Question 33(continued)

(c) Comment on whether the first claim made by the salt manufacturer was upheld. **2**

(d) How could the student investigate the second claim on the label? **2**

Student Name

Student Number

Question 34 (4 marks)

CRISPR gene editing is a technology that has been used by scientists to modify DNA.

In 2018, Chinese scientist He Jianui and his collaborators used this technology to create the first genome-edited babies in an attempt to solve fertility problems.

As a consequence of his work, the World Health Organisation launched a global registry in 2019 to track research on human genome editing, after a call to halt all work on genome editing.

Evaluate the importance of a code of conduct in monitoring and regulating biotechnology. **4**

End of exam

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Section II - Extra writing space

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

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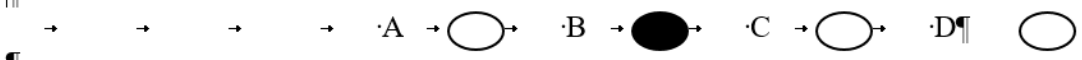
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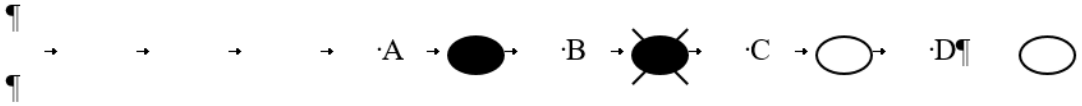
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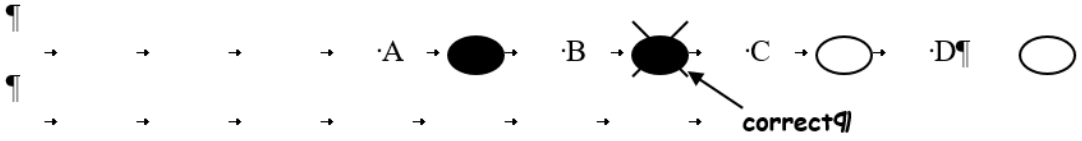
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Investigating Science

Section II Answer Booklet

Section II – 80 marks
Attempt Questions
Allow about 2 hours and 25 minutes for this section.

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 on
pages 30 and 31.

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

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Question 21 (4 marks)

A student was investigating the hypothesis that paper planes with larger wings stay in the air longer than paper planes with smaller wings.

(a) Identify the independent and dependent variables. **2**

Independent variable:

Dependent variable:

Question 24
a) Correctly identifies both independent and dependent variables ***Sample answer*** ***a) Independent: time of flight; Dependent variable: area of wing***

2

(b) List any variables that would need to be controlled in order to design a valid experiment.

b) Lists more than two variables that need to be controlled **List two variables that need to be controlled**	**2** **1**
Sample answer ***b) Independent: time of flight; Dependent variable: area of wing*** ***c) Controlled variables: mass of plane, shape of plane, power of throw, angle of throw, wind strength and direction, angle of wings***	

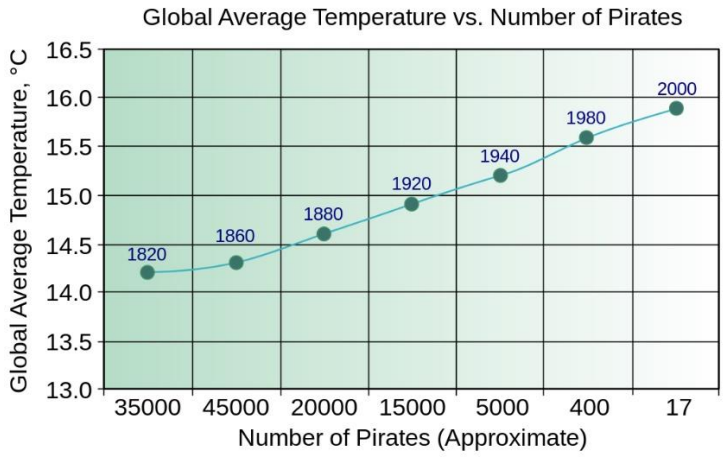
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Question 22 (3 marks)

With reference to the graph shown, evaluate the statement: **3**

"Stop Global Warming – become a Pirate"



Question 32	**3**
Correctly identifies the link between variables **Correctly identifies correlation does not equal causation by referring to the graph** **Correctly identifies correlation does not equal causation without referring to the graph**	**3** **2** **1**
Sample Answer ***Link between variables – less pirates = higher temperatures. However, correlation does not equal causation. There is no causal connection between becoming a pirate and global warming.***	

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Question 23 (3 marks)

During the course, you investigated a scientist who falsified their scientific results.

Drawing on this example, discuss how the peer review process could have been used to uncover fraudulent research. **3**

Correctly discusses the process of peer review and link to an example. Must have at least ONE elaboration with example. **Correctly describes the process of peer review and linked to an example.** **Correctly describes the process of peer review OR gives an example**	**3** **2** **1**
Sample Answer ***The article written by Maggie Simpson and Edna Krabappel was published in two separate scientific journals, although the article made no sense and was written by fraudulent writers.*** ***Peer review is the evaluation of work by one or more people to ensure quality standards, improve performance and provide credibility. The peer review would have ensured that this article was not credible on a number of different levels. The reviewers would have picked up the fake names and the fact it was made up of entirely a random string of words.***	

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Question 24 (9 marks)

Below is an extract from an SDS (Safety Data Sheet) on Hydrochloric acid.

2. HAZARDS IDENTIFICATION

Emergency Overview:	DANGER! Corrosive. Causes severe skin, eye, and digestive tract burns. Harmful if swallowed. Mist or vapor extremely irritating to eyes and respiratory tract.
Safety Ratings:	Health: 3, Severe — Reactivity: 1, Slight Flammability: 0, None — Contact: 4, Extreme
OSHA Regulatory Status:	This product is considered a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
Potential Acute Health Effects:	
Routes of Exposure:	Inhalation, ingestion, skin contact, eye contact
Inhalation:	Corrosive. May cause damage to mucous membranes in nose, throat, lungs and bronchial system.
Ingestion:	Corrosive. Harmful if swallowed. May produce burns to the lips, oral cavity, upper airway, esophagus and digestive tract.
Skin Contact:	Corrosive. Causes severe burns.
Eye Contact:	Corrosive. Causes severe burns. Vapor or spray may cause eye damage, impaired sight or blindness.
Target Organs:	Skin, respiratory system, eyes, lungs
Chronic Health Effects:	Corrosive. Prolonged contact causes serious tissue damage.

A student wished to conduct an experiment to determine whether the temperature of hydrochloric acid influenced the rate of its reaction with a strip of magnesium metal.

(a) With reference to the SDS extract, describe TWO safety procedures that the student should follow when using hydrochloric acid. **2**

Marking Criteria	Marks
• TWO safety procedures described, relevant to the SDS	2
• ONE relevant safety procedure described.	1

The SDS mentions that the chemical can cause burns to eyes, so eye protection should be worn. Also, the chemical can burn skin, so appropriate gloves should be worn when handing the chemical

Question 24 (continued)

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(b) Outline a valid, reliable and safe method that could be used to determine the relationship between the temperature of hydrochloric acid and its reaction rate with magnesium ribbon. **4**

Marking Criteria	Marks
• **Full outline of a feasible method, incorporating:** - **the measurements performed** - **equipment used and steps performed, including safety considerations** - **how a conclusion could be drawn** - **reliability and validity of data**	**4**
• **Outline of feasible method incorporating most of the above features.**	**3**
• **Outline of method incorporating some of the above features.**	**2**
• **Aspects of an applicable method stated.**	**1**

1. ***Gather the following equipment and items: electronic heat bath and stirrer, 125mL round bottomed flask, 250mL beaker 20 1cm strips of magnesium ribbon, 50mL measuring cylinder, 1M hydrochloric acid, latex gloves, labcoat, safety glasses, stopwatch***
2. ***Wear all PPE and ensure that glassware is not near the edge of the bench and that the HCl bottle is open only as long as is necessary for pouring reagent.***
3. ***Pour approximately 50mL of HCl into the beaker, then transfer 40mL of the HCl into the measuring cylinder.***
4. ***Set the heat bath to 30 degrees Celsius, pour the HCl into the round bottomed flask and put the flask into the heat bath. Wait until the temperature of the HCl is at the same temperature as the heat bath.***
5. ***Drop a strip of magnesium ribbon into the flask, immediately start the stopwatch and observe/record the time taken for the magnesium strip to fully react.***
6. ***Repeat step 5 3 more times and record the results.***
7. ***Repeat steps 4-6 for temperatures of 40, 50, 60 and 70 degrees.***

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(c) Describe a source of random error in your method, and suggest how the impact of this error could be minimised. **3**

Marking Criteria	Marks
• **Source of random error and how impact of error can be reduced fully described**	**3**
• **Strategy to reduce random error described OR named source of random error described**	**2**
• **Some relevant aspect of random error correctly stated.**	**1**

The heat bath temperature reading may not accurately reflect the temperature within the HCl. Use of an additional thermometer within the solution to gather another temperature reading may help reduce the effect of this error.

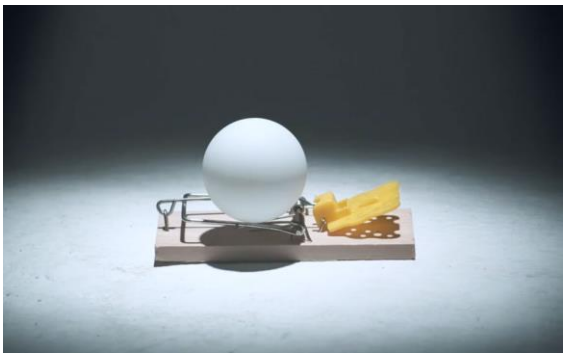
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Question 25 (10 marks)

A student was studying the spread of disease and developed a model to investigate the relationship between organism distancing and the rate of spread of a disease.

The model involved loading mousetraps with ping pong balls and spacing them around an enclosed area with various spacing densities.



40 such mousetraps were loaded with TWO ping pong balls each and spaced at different densities, and the total amount of mousetraps that had been activated within a 30 second period was recorded.

The data that the student gathered was averaged and shown in the table below:

Mousetrap density (traps/unit area)	0	2	4	6	8	10	12	14	16
Number of traps activated in 30 seconds	0	1	4	8	15	24	36	39	40

(a) State the independent variable in this investigation. **1**

Marking Criteria	Marks
• Correctly states the independent variable	1

The independent variable is the mousetrap density

Question 25 continues on the next page

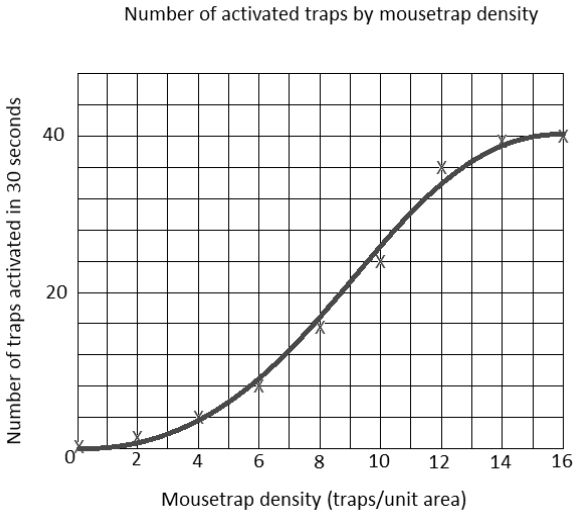
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Question 25 (continued)

(b) Using the grid below, appropriately graph the data. **5**

Marking Criteria	Marks
• **Curve of best fit graph with appropriate title, axes labelled, units correct, appropriate scale and correct plot (note that curve as well as point joining is acceptable)**	**5**
• **All of the above with one omission.**	**4**
• **All of the above with two omissions.**	**3**
• **All of the above with three omissions.**	**2**
• **Some reasonable attempt at a graph made.**	**1**



(c) Describe the trend demonstrated by the data. **2**

Marking Criteria	Marks
• **General trends shown by the data described fully, referring to variables and constraints in experiment.**	**2**
• **An aspect of a trend outlined.**	**1**

As the mousetrap density increases, the number of traps activated in 30 seconds increases at an increasing rate until it begins to approach to traps (the total number of traps in the experiment) after which time it begins to plateau at 40 (the maximum amount that can be activated in the experiment).

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(d) Explain what aspect of the study is being modelled by the ping pong balls. **2**

Marking Criteria	Marks
• Explains the role of ping-pong balls in the study	2
• States the role of ping-pong balls	1

The ping-pong balls represent the number of people that can get infected from a single host, so in a way represents the infectivity of the disease. The larger the number of balls, the larger amount of subsequent traps that can "catch" the disease.

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Question 26 (6 marks)

Two advertisements for breakfast cereals are shown below.

Crunchy Bites



Cereal Crunch



(a) Compare the advertising techniques of the two cereal companies, Crunchy Bites and Cereal Crunch. **3**

Criteria	Marks
• Identifies features of emotive and evidence-based ads • Provides similar and different features across both advertisements	3
• Provides similar feature(s) across both advertisements • Provides different feature(s) across both advertisements	2
• Identifies an advertising feature	1

Sample answer

The two advertisements employ two different techniques in their promotion. The Crunchy Bites ad has no scientific information but uses a lot of positive emotional imagery and language such as a happy woman consuming cereal and the phrase #choosehappiness. The Cereal Crunch ad provides some data in the form of sugar content and the number of vitamins. Both advertisements use positive imagery of a portion of cereal to promote the cereal.

(b) Explain how these techniques could persuade consumers to purchase their brand of cereal. **3**

Criteria	Marks
• Identifies the two types of advertisements as emotive and fact-based • Relates effect of both fact-based and emotive advertisements techniques to consumer choices	3
• Identifies the two types of advertisements as emotive and fact-based • Relates effect of both fact-based or emotive advertisements techniques to consumer choices	2
• Provides some relevant information	1

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Sample answer

Crunchy Bites uses emotive based advertising techniques such as the hashtag #choose happiness. This is misleading as it suggests to consumers that their happiness is directly related to their consumption of the cereal. Cereal Crunch employs fact-based advertising techniques by stating some data. Consumers may choose to purchase Cereal Crunch as it is promoted as being healthier than other brands by containing less sugar.

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Question 27 (6 marks)

In July 2018, Australia founded the Australian Space Agency (ASA). The ASA would be responsible for coordinating and providing advice on the civil and space sector, as well as administering space activities legislation and delivering on our international obligations. In order to achieve this, the agency was given an annual budget of 9.8 million dollars.

Discuss the controversy surrounding funding for space exploration. **6**

Criteria	Marks
• Provides arguments for and against space funding • Demonstrates extensive knowledge regarding funding for space exploration	5-6
• Provides an argument for space funding • Provides an argument against space funding • Demonstrates knowledge regarding funding for space exploration	3-4
• Provides an argument for OR against space funding • Shows some knowledge of space funding	2
• Provides some relevant information	1

Sample answer

It has been argued for many years that the funding for space explorations does not outweigh the benefits. Many argue that the funding could be instead used to solve more pressing issues such as food shortage and global warming. Many believe it should be the priority of governments to meet the needs of the people currently living on our planet. It is also the nature of humankind to explore and there is also much that we do not know about our current planet, its inhabitants and the materials on it. There is also the view that the money being funded is part of a space race that is designed to cater to a country's ego.

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Question 28 (3 marks)

Discuss how the development of flight has benefited society and affected the overall public perception of science. **3**

Criteria	Marks
• Describes at least TWO benefits to society of the development of flight • Outlines at least TWO valid positive changes to the public image of science	3
• Describes at least ONE benefit to society of the development of flight • Outlines at least ONE valid positive change to the public image of science	2
• Makes a relevant statement linking a benefit of flight and its public image	1

Sample answer: Discovering a way for people to take flight was an awe-inspiring feat and was seen as a great step forward for science. To design a successful airplane, engineers had to master not just gravity but three other forces and keep them in balance. There have been, and continue to be, problems, but overall it has changed people's lives.

Some of the benefits of flight include: (three only required)

- The fast transport of people, animals, luggage, medical supplies and many other items
- Improving the quality of communications
- The pursuit of leisure activities, business relationships and connections with friends and family
- Driving economic growth and employment
- Enabling sustainable development
- Supporting world health, the space industry and military operations

The continued development of flight has seen humans land on the moon six times, explore the solar system and even venture into space beyond the solar system. This has undoubtably attracted an admiration for and belief in science and its ability to solve complex problems. In general, flight is seen as a necessity and its public image remains strong.

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Question 29 (5 marks)

Iridology claims that colours, patterns, and various other properties of the iris can be used to assess an individual's general health. Iridology practitioners and followers believe that each organ in the human body has a corresponding region in the iris. Thus, the organ can be examined by inspecting the iris.

Analyse the above claim to discuss that identifying pseudoscience is important to maintain the integrity of Science. **5**

Criteria	Marks
Provides a thorough analysis of the claim AND Provides the rigour of scientific process AND Discusses that Iridology does not meet the rigour of scientific process AND Identifies what is pseudoscience AND Provides reasons why pseudoscience is important to maintain the integrity of Science	**5**
Any four of the above	**4**
Any three of the above	**3**
Any two of the above	**2**
Provides some relevant information about pseudoscience or scientific process	**1**

Sample answer:

Scientific process involves asking questions leading to a hypothesis for an investigation. The process then involves designing an experiment or investigation, collecting data and then analysing data. Sometimes this process can take years as the scientists need to provide proof for the their investigation to the scientific community for the work to be acknowledged and widely used. The components of the investigation have to be accurately measured and variables need to be controlled while changing and measuring variables under investigation. This process is rigorous and maintains the integrity of science.

Pseudoscience as the name suggests is a fake science. Many practices such as iridology claim as mentioned in the question above that there is a connection between the variables. Iridology claims that each organ in the human body has a corresponding region in iris. Thus, the organ can be examined by inspecting the iris. This claim seems to be grounded in science but in fact there is no valid link between the supposed variables mentioned by iridologists.

It is important that consumers understand this difference as science rigour needs to be identified as health issues need to be dealt with precision and knowledge derived by

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scientific process and not just a popular practice. Consumers need to realise that investigations performed in iridology field do not match the requirements or standards set by published and practiced science health professionals. Educational programs ned to be devised to ensure that consumers are swayed by complex terminology and language of pseudoscience.

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Question 30 (5 marks)

Science related events affect society's view of Science.

Use the Chernobyl nuclear meltdown of 1986 to discuss the effect of this incident on the public image of science. **5**

Criteria	Marks
Provides a thorough discussion on Chernobyl nuclear meltdown and its impact on community **Shows a thorough understanding of how Chernobyl nuclear meltdown affected society's view of Science** **Includes the relevant reason for science to develop nuclear plants**	**5**
Provides some discussion on the Chernobyl nuclear meltdown **Shows a sound understanding of how Chernobyl nuclear meltdown affected society's view of Science** **Includes relevant reason for science to develop nuclear plants**	**4**
Outlines issues associated with Chernobyl nuclear meltdown and societal reaction **AND** **Includes some reason for science to develop nuclear plants**	**3**
Shows some understanding of Chernobyl nuclear meltdown and its impact on the community	**2**
Provides some relevant information	**1**

Sample answer:

A nuclear reactor produces energy through the proves of nuclear fission, where atoms split and release energy. These nuclear reactors are used to produce enormous amount of low-carbon electricity.

Flawed reactor design and insufficiently trained workers who violated several operating regulations were responsible for the most disastrous accidents in the history of nuclear industry – the Chernobyl nuclear meltdown. The incident was during a routine safety check of the plant which led to an unexpected power surge ending in series of explosions that blew up the reactor and released 5% of the radioactive reactor core into tge environment with the deposition of radioactive material in many parts of Europe.

As Chernobyl nuclear meltdown caused serious social and economic disruption for the large populations in Belarus, Russia and Ukraine. The lighter material was carried by wind to some extent over Scandinavia and Europe. People had to evacuated from the region immediately leading to loss of home. In months following the accident, hospitals reported people flooding in with acute symptoms of radiation poisoning.

The Chernobyl nuclear meltdown affected the public opinion on nuclear energy. The opposition to nuclear power increased significantly. Countries located geographically closer to the Chernobyl nuclear plant had significantly more psychological impacts and

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heightened fear. The proportion of citizens opposed to nuclear programs spiked immediately after the accident.

The negative public opinion towards science related research like the nuclear research led the scientific community and the government to put policies and procedures in place for better information handling and risk management of any event. There was a push towards increased preparation for scientific accidents and management before setting up of any industry. This led to the development of safety culture among industries and their governing bodies.

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Question 31 (4 marks)

Approximately 300 million people died from the highly contagious disease, smallpox, during the 20th century. Despite being globally eradicated by 1980, samples of the virus are still held at two laboratories, one in America and one in Russia.

Evaluate the ethics of keeping these samples. **4**

Criteria	Marks
• Provides a judgement of the ethics of keeping smallpox samples with reference to the reasons for and against this decision	4
• Provides a judgement of the ethics of keeping smallpox samples with ONE reason for and ONE reason against this decision OR • States reasons for and against the decision to keep samples of smallpox	2–3
• States a relevant reason for OR against the decision to keep samples of smallpox	1

Sample answer: Smallpox only infects humans. Keeping samples of the virus would allow researchers to test better vaccines and drugs for use against new and future viral outbreaks. Even though smallpox has been eradicated there is a possibility that it could survive in dead tissue or that some strains of smallpox may still be out there in forgotten frozen vials. If an outbreak occurs, having samples of the smallpox virus would help scientists deal with the problem especially as vaccine immunity wanes over time. Vaccines and medications tested against variola virus could also prove useful in treating other poxviruses, e.g. monkeypox.

However, there is a good argument to destroy the remaining smallpox samples. The last natural case of smallpox was diagnosed in 1977, and today, the risk of a smallpox outbreak emerging, for a disease that's no longer around, is extremely small.

Maintaining the samples comes with a high risk of accidental release and any release, no matter how small the risk, is unacceptable. Having the live virus around is not vital to achieve research goals. Researchers could test new vaccines and drugs against smallpox relatives like vaccinia and monkeypox.

Anti-viral drugs have already been prepared in the event that a smallpox outbreak or bio-terrorist attack becomes a reality.

This topic is controversial and although good points can be argued on both sides of the debate the consequences of another epidemic occurring outweigh its possible research value. The samples should be destroyed.

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Question 32 (7 marks)

Scientific investigations on humans can be affected by bias from both the participant and the researcher. Two ways in which research can reduce or eliminate this bias is by conducting 'single-blind trials' or 'double-blind trials.'

(a) Define the term blind trial and distinguish between a single-blind and a double-blind trial. **2**

Criteria	Marks
• Defines the term *blind trial* • Indicates a difference between a single-blind and a double-blind trial by referring to the role of the investigator	2
• Makes a correct statement that indicates a difference between a single-blind and a double-blind trial	1

Sample answer: A blind trial is a treatment in which the recipient does not know if he is receiving the treatment or an alternative such as a placebo.

In a single-blind trial the person administering the treatment is aware of who is receiving the treatment. Double-blind trials are specifically designed to eliminate or reduce the chance of the participants and the investigator influencing the findings. In this case neither the participants nor the person conducting the testing knows who is receiving a particular treatment.

(b) In August 2018, the FDA (US Food and Drug Administration) released a document suggesting investigators should stop using double blind clinical trials with placebo products when treating people who are suffering from an illness. **2**

Suggest a reason for this approach

Criteria	Marks
• Suggests a relevant reason to explain why the FDA recommends stopping double-blind trials for certain diseases	2
• Makes a relevant statement about blind trials for certain diseases	1

Sample answer: Although it is common practice to use double-blind trials and placebos, it would be considered unethical to administer a non-active treatment to patients suffering from serious, life-threatening conditions such as cancer. In these cases, all trial patients should receive the treatment and the clinician should know who received it because there could be concerns over ongoing treatments or side effects that have been incorrectly attributed to the treatment.

Question 32 continued on the next page

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Question 32 (continued)

(c) State the aim and outline a suitable method that could be used to conduct a double-blind trial to investigate the following question:

Can people tell the difference between brand name lemonade and generic supermarket lemonade? **3**

Criteria	Marks
• Designs a double-blind trial to investigate the question and includes: – An appropriate aim – The appropriate sample preparation to provide 'double blindness' – How data is correctly collected	3
• Designs a double-blind trial to investigate the question and includes TWO of: – An appropriate aim – The appropriate sample preparation to provide 'double blindness' – How data is correctly collected	2
• Makes a correct statement about how a double-blind trial could be designed	1

Sample answer:
Aim: To determine the ability of people to identify the difference between a brand name and a supermarket brand lemonade.
Method:
Steps 1 to 3 are conducted by a laboratory technician who is not the experimenter.

1. 200 identical cups are labelled; 100 are labelled A and 100 are labelled B.
2. Cups labelled A are filled with 50 mL of brand name lemonade and cups labelled B are filled with 50 mL of supermarket lemonade.
3. All cups are kept at room temperature and are collected by the experimenter.
4. 100 people are separately and individually given the two samples by the experimenter.
5. The experimenter asks each person – "Is there a difference in taste between A and B" and then records the result.
6. If the person's answer is 'yes' the experimenter will ask – "Which do you think is the brand name lemonade?" and records the result.
7. The researcher then statistically analyses the results.

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Question 33 (11 marks)

A student became annoyed that whenever the salt shaker was used on food only a very small amount of salt came out because the holes became blocked. The student went out and bought a packet of salt, the label of which is shown below.

"Fast Flow" Table Salt

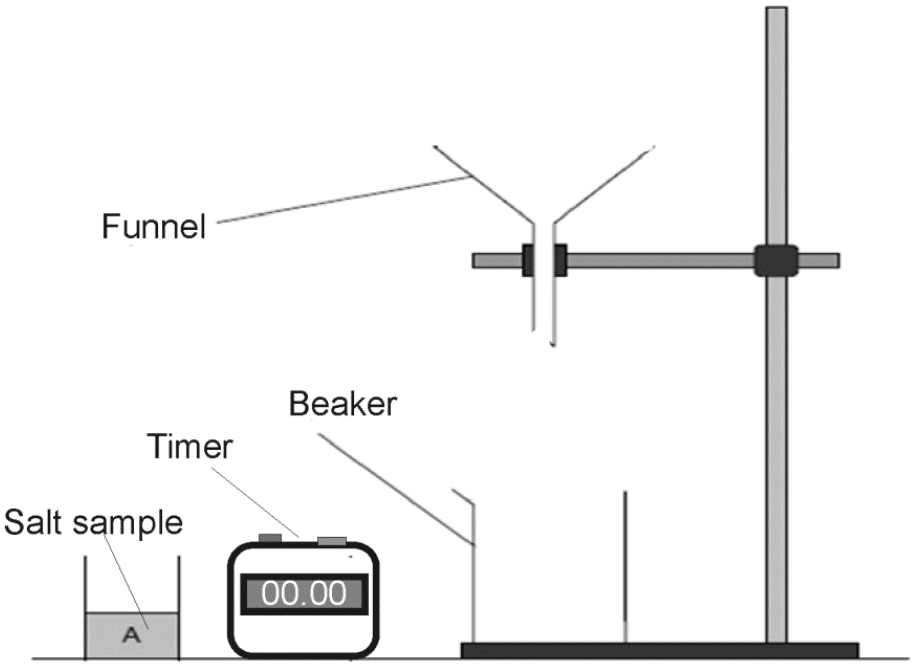
Fed up with salt clogging up in the shaker?
This salt will pour free and fast every time!
Contains special ingredients to ensure a smooth flow

Quick Acting Table Salt

500g

© QATS 2020

Despite the claim to "pour free and fast", the new product did not seem to be much better than the old one. The student decided to test the claims made on the label by comparing this salt with three other types using the apparatus shown below. This was set up in a school science laboratory as shown in the diagram.



Question 33 continued on next page

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Question 33 (continued)

Part of the student's write up is shown below.

> Method:
>
> Three different types of salt were tested: the original brand, 'Fast flow" table salt and supermarket "own brand".
>
> 100g of the salt under test was weighed into a dry beaker. This was poured into the filter funnel and how long all of the salt took to pour into the lower beaker was timed.
>
> This was repeated twice.
>
> Results:
>
> The original type of salt took: 12.5 seconds, 11.7 seconds and 12.1 seconds
>
> Fast flow took: 21.7 seconds, 10.9 seconds and 11.8 seconds
>
> "Own brand" took: 12.1 seconds, 12.4 seconds and 11.9 seconds.

(a) Draw a table with suitable headings containing the results and calculate the average time for each. **4**

Criteria	Marks
• **Draws table with appropriate headings AND includes all data AND calculates averages correctly**	**4**
• **Draws table with appropriate headings AND includes all data AND calculates some averages correctly**	**3**
• **Draws table with appropriate headings AND includes most data**	**2**
• **Draws a table with some details**	**1**

Sample answer:

	Time 1 (sec)	*Time 2 (sec)*	*Time 3 (sec)*	*Average (sec)*
Original	***12.5***	***11.7***	***12.1***	***12.1***
"Fast Flow"	***11.3***	***10.9***	***11.8***	***11.2***
"Own brand"	***12.1***	***12.4***	***11.9***	***12.1***

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(b) Comment on the validity, reliability and accuracy of the procedure used by the student. **3**

Criteria	Marks
• Makes valid comments on all THREE aspects of procedure	3
• Makes valid comments on TWO aspects of procedure	2
• Makes valid comments on ONE aspect of procedure	1

Sample answer:
Validity refers to whether the research actually tests what it is supposed to test. The student tried to replicate the situation of shaking salt on food but poured rather than shaken. This would eliminate difficulties of giving the same amount of shaking every time. Reliability: the results were fairly consistent – agreeing within a fraction of a second. Accuracy is more difficult to determine. Not told how weighing was done. Also, the human error/response time (random error) when using a timer to measure a relatively short event.

(c) Comment on whether the first claim made by the salt manufacturer was upheld. **2**

Criteria	Marks
• Makes valid comment making TWO points	2
• Makes ONE valid point	1

Sample answer
The maker claimed it would pour fast and free very time, not faster than other products. (However, it poured slightly faster than the original and "own brand" and much faster than sea salt.) It would depend on what your expectation of "fast" was. More brands of salt may have to be tested.

(d) How could the student investigate the second claim on the label? **2**

Criteria	Marks
• Makes valid suggestion making TWO points	2
• Makes ONE valid point	1

Sample answer
Look at the ingredients to see what there was apart from salt. Then research to see if this ingredient is designed to have any role in how salt flows.

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Question 34 (4 marks)

CRISPR gene editing is a technology that has been used by scientists to modify DNA.

In 2018, Chinese scientist He Jianui and his collaborators used this technology to create the first genome-edited babies in an attempt to solve fertility problems.

As a consequence of his work, the World Health Organisation launched a global registry in 2019 to track research on human genome editing, after a call to halt all work on genome editing.

Evaluate the importance of a code of conduct in monitoring and regulating biotechnology. **4**

Criteria	Marks
• Relates the importance of the code of conduct in regulation and monitoring • Describes conduct issues(s) associated with biotechnology • Supports a judgement about the importance of a code in biotechnology	4
• Explains the importance of the code of conduct in regulation and monitoring • Describes some aspects of conduct issues(s) associated with biotechnology • May make a judgement about the importance of a code in biotechnology	3
• Outlines some features of conduct issues in biotechnology	2
• Provides some relevant information	1

Sample answer

The scientific codes of conduct allow scientists to perform research under a uniform set of rules and regulations. These rules uphold international standards of research and prevent the crossing any major ethical boundaries. Each country or organisation is responsible for framing the codes of conduct and monitoring the relevant scientific organisations to ensure they adhere to these guidelines.

One such field of science governed by the code of conduct is biotechnology. Biotechnology is the exploitation of organisms or their products to create useful products, often for industrial or commercial purposes. Areas of biotechnology include gene editing and stem cell research. These aspects of science are highly controversial as they involve the manipulation of natural processes and scientists are often referred to as 'playing god'. Others believe that it may open new avenues of science that could lead to unintended consequences. Therefore, it is imperative that clear guidelines and strict codes of conduct are set out to ensure that countries and organisations comply with international research standards and to avoid any destructive outcomes.

End of exam

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