# 2022 HSC Investigating Science Marking Guidelines

## Section I

### Multiple-choice Answer Key

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

# Section II

## Question 21

| Criteria | Marks |
|---|---|
| • Identifies TWO relevant sections<br>• Provides relevant purpose for each | 3 |
| • Identifies TWO sections<br>OR<br>• Identifies a section and provides a relevant purpose | 2 |
| • Identifies a section or purpose | 1 |

***Sample answer:***

| *Section of investigative report* | *Purpose of this section* |
|---|---|
| Method | So that other investigators can replicate the investigation |
| Results | To show the data collected in the investigation |

## Question 22 (a)

| Criteria | Marks |
|---|---|
| • Demonstrates a sound understanding of accuracy<br>• Makes a correct judgement about the accuracy of the balances<br>• Refers to data from the table | 3 |
| • Demonstrates a basic understanding of accuracy<br>• Makes a correct judgement of the accuracy of a balance<br>OR<br>• Makes a correct judgement of the accuracy of a balance<br>• Refers to data from the table<br>OR<br>• Refers to data from the table<br>• Demonstrates a basic understanding of accuracy | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

The analogue balance is more accurate as the readings are within 0.01–0.03 kg of the known mass. The digital balance is not as accurate as the readings are within 0.12–0.15 kg of the known mass.

## Question 22 (b)

| Criteria | Marks |
|---|---|
| • Provides relevant steps to reduce error<br>• Provides reasons for the steps | 3 |
| • Provides correct step(s) to reduce error<br>AND/OR<br>• Makes a correct justification of the step(s) taken | 2 |
| • Provides a relevant step | 1 |

***Sample answer:***

The measurement should be repeated more times under the same conditions to identify whether results are consistent. Outliers should be identified and removed from the data set and the remaining values should be averaged to reduce random error.

## Question 23

| Criteria | Marks |
|---|---|
| • Makes a judgement about the effect of scientific research on human progress<br>• Provides relevant criteria for the judgement<br>• Provides a relevant example to support the judgement on human progress | 4 |
| • Outlines an effect of scientific research on human progress<br>• Uses a relevant example to support the response<br>OR<br>• Provides relevant criteria for the judgement<br>• Uses a relevant example to support the response<br>OR<br>• Outlines an effect of scientific research on human progress<br>• Provides a relevant judgement | 3 |
| • Identifies an effect of scientific research on human progress<br>• Refers to a relevant example | 2 |
| • Provides some relevant information | 1 |

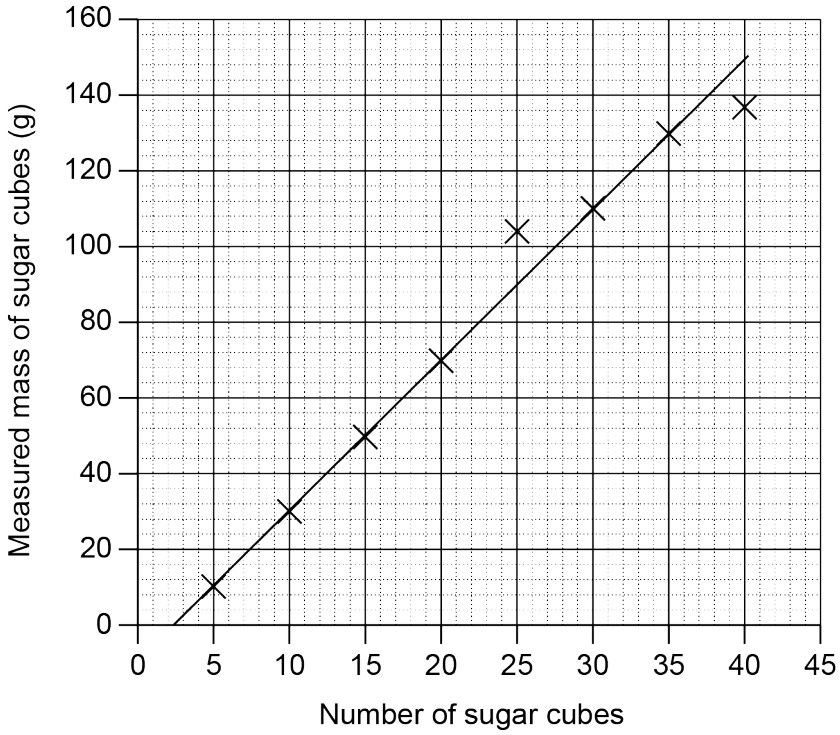
***Sample answer:***

Scientific research in the automotive industry has led to the development and the use of robots. These have taken the place of workers, assembling parts, welding, painting and handling hazardous chemicals. This is a positive outcome as it has reduced workplace injuries and human production errors. On the other hand using robots in industry has decreased employment opportunities for workers. Overall, the positive impact of scientific research into robotics for the automotive industry outweighs the impact of the job losses.

## Question 24 (a)

| Criteria | Marks |
|---|---|
| • Provides a graph with:<br>– correct labels<br>– linear scales with correct units<br>– data points correctly plotted<br>– LOBF that doesn't include outliers OR (0, 0)<br>– correct independent/dependent variables on appropriate axes | 4 |
| • Provides a substantially correct graph | 3 |
| • Provides some elements of a correct graph | 2 |
| • Provides an element of a correct graph | 1 |

***Sample answer:***



## Question 24 (b)

| Criteria | Marks |
|---|---|
| • Identifies TWO features of the line of best fit<br>• Provides reasons for the identified features | 3 |
| • Identifies TWO features of the line of best fit<br>OR<br>• Provides a reason for an identified feature | 2 |
| • Identifies some relevant information concerning a line of best fit | 1 |

***Sample answer:***

The line of best fit did not pass through the origin. This is probably due to a systematic error in the way the measurements were taken, such as not taring the balance correctly. Although most of the data points were close to the line of best fit, two were clearly outliers, most likely due to random error in those readings.

## Question 24 (c)

| Criteria | Marks |
|---|---|
| • Calculates correct value, making use of data from graph | 2 |
| • Provides a value that has made use of data from the graph | 1 |

***Sample answer:***

$$\text{From graph, gradient} = \frac{\text{rise}}{\text{run}} = \frac{(120 - 0)\,\text{g}}{(32.5 - 2.5)\,\text{sugar cube}} = 4.0\ \text{g / sugar cube}$$

***Answers could include:***

If incorrect graph drawn in part (a), then two marks still possible if incorrect graph used correctly.

## Question 25

| Criteria | Marks |
|---|---|
| • Provides features and characteristics of the method used to calculate circumference<br>• Justifies the suitability of the methodology used | 5 |
| • Outlines the method used to calculate circumference<br>• Justifies the suitability of the methodology used | 4 |
| • Identifies feature(s) of the method used to measure circumference<br>AND/OR<br>• Identifies a correct methodology | 2–3 |
| • Provides some relevant information | 1 |

***Sample answer:***

Eratosthenes used experimental testing and fieldwork to measure the angles of shadows at two locations a known distance apart, at the same time of day, when the sun was directly overhead at one location. Using these data, he could calculate Earth's circumference. The method of collecting the data was suitable at that time as he was able to effectively calculate the circumference of Earth with only a few measurements. Subsequent experiments were able to verify Eratosthenes' value to be close to the actual value.

***Answers could include:***

Other ways to justify the methodology.

## Question 26

| Criteria | Marks |
|---|---|
| • Provides a detailed outline of the partnership<br>• Links impacts to partnership | 4 |
| • Provides a limited outline of the partnership<br>AND/OR<br>• Links impact(s) to the partnership | 2–3 |
| • Provides some relevant information | 1 |

***Sample answer:***

The Indjalandji–Dhidhanu people have established links with the University of Queensland to develop nanotechnology from harvesting spinifex on their lands. The nanofibres extracted from spinifex can be incorporated into composite materials for strength and flexibility and have significant commercial applications. The benefits to both parties of this sharing are extensive. It creates employment opportunities in a remote area and brings profits to both parties, while providing future directions for further research and commercial development.

## Question 27

| Criteria | Marks |
|---|---|
| • Demonstrates a thorough understanding of the experimental method used<br>• Identifies relevant variables<br>• Provides a reason for controlling a variable | 4 |
| • Provides a substantially correct method<br>• Identifies relevant variables | 3 |
| • Provides some step(s) in the method used<br>AND/OR<br>• Identifies relevant variable(s) | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

Van Helmont dried soil in an oven and weighed it. He weighed and planted a small tree in a pot containing the dried soil. The tree was left to grow for five years. The soil was covered to prevent dust from mixing with the soil, controlling soil mass. The plant was watered regularly with distilled water, preventing dissolved solids contributing to the weight of the soil. The soil was removed from the pot, dried and weighed to see if the plant had consumed the soil in order to grow. The tree was also weighed.

## Question 28

| Criteria | Marks |
|---|---|
| • Provides a specific example of collection and manipulation of data<br>• Relates economic influences to the collection and manipulation of data<br>• Produces a logical and coherent analysis | 7 |
| • Provides specific examples of collection or manipulation of data<br>• Relates economic influence(s) to the collection or manipulation of data | 5–6 |
| • Provides an example of collection or manipulation of data<br>AND/OR<br>• Relates the example to the economic influence(s) on the collection or manipulation of data | 3–4 |
| • Outlines an economic influence<br>AND/OR<br>• Outlines a relevant example | 2 |
| • Provides some relevant information | 1 |

***Answers could include:***

A specific example, eg:
- Tobacco industry
- Fossil fuel industry
- Asbestos industry

Economic influences, eg:
- Time pressure
- Profit
- Research funding

Collection of data, eg:
- Sample size
- Bias
- Suppression of data
- Financial pressure

Manipulation of data, eg:
- Misinterpretation
- Misrepresentation
- Cherry picking
- Exclusion/inclusion of outliers.

## Question 29 (a)

| Criteria | Marks |
|---|---|
| • Provides a logical sequence of steps that would gather appropriate data<br>• Identifies a hazard and addresses a safety issue<br>• Addresses reliability | 5 |
| • Provides a series of steps that would gather appropriate data<br>• Addresses safety or reliability | 4 |
| • Provides most of the steps needed to gather data<br>• Addresses safety or reliability | 3 |
| • Provides some of the steps needed to gather data<br>• Addresses safety or reliability | 2 |
| • Provides some relevant information | 1 |

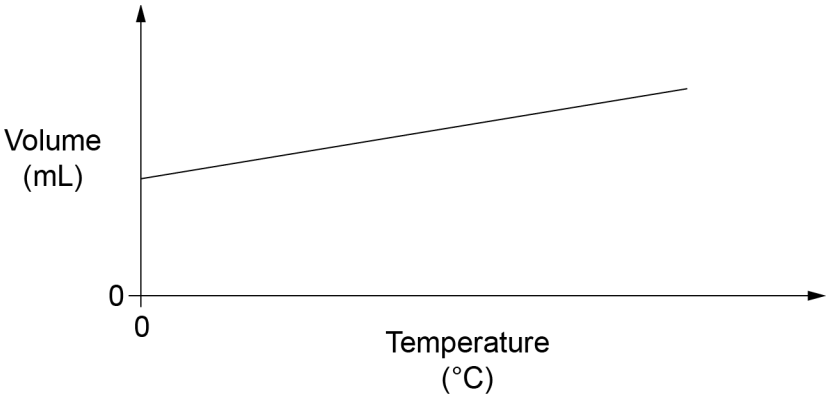
***Sample answer:***

1. A series of water baths from 0°C to 100°C are set up. Protective gloves must be used since the hot water baths contain scalding water, which can cause serious burns.
2. A syringe is half filled with air and then sealed.
3. A thermometer is placed in the water bath.
4. For each water bath, the syringe is placed in the water and allowed to reach the same temperature as the water bath.
5. The volume of air inside the syringe and the temperature of the water are then recorded for each water bath.
6. Results from other groups in the class are compared to each other to check consistency of results.

## Question 29 (b)

| Criteria | Marks |
|---|---|
| • Provides appropriate labels and units<br>• Provides independent and dependent variables on appropriate axes<br>• Provides an appropriate sketch of the graph, consistent with the units used | 2 |
| • Provides appropriate units and labels on correct axes | 1 |

***Sample answer:***




***Answers could include:***

An appropriate graph with alternate units.

## Question 30

| Criteria | Marks |
|---|---|
| • Demonstrates thorough knowledge of a technological development to the LHC<br>• Relates development to the discovery of the Higgs boson | 4 |
| • Demonstrates sound knowledge of a technological development to the LHC<br>• Relates development to the discovery of the Higgs boson | 3 |
| • Demonstrates some knowledge of a development to the LHC<br>OR<br>• Relates development to the discovery of the Higgs Boson | 2 |
| • Identifies a relevant development | 1 |

***Sample answer:***

The original super-conducting magnets of the Large Hadron Collider (LHC) were improved, which allowed their strength to be increased. This increased collision energy of the particles being accelerated. During experiments in 2012, the LHC allowed for the observation of a particle in the same mass region consistent with the Higgs boson particle.

***Answers could include:***

References to:

- Detection of particles with short half-life
- Increased sensitivity of instruments.

## Question 31

| Criteria | Marks |
|---|---|
| • Provides specific outlines of different perspectives<br>• Outlines scientific research that has been triggered by these perspectives<br>• Links perspectives to scientific research<br>• Makes a judgement about the influence of perspectives on scientific research | 4 |
| • Provides an outline of a perspective<br>• Identifies scientific research that has been triggered by this perspective<br>• Links perspective to scientific research or provides a relevant judgement | 3 |
| • Identifies perspective(s)<br>AND/OR<br>• Identifies relevant scientific research | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

Tapeworms were used in the past to reduce a person's weight, however this treatment is no longer considered ethical due to risks involved in the procedure. Scientific research has been driven by societal pressure to develop new technologies such as gastric band surgery to reduce the size of the stomach and hence control weight. Without the change in society's perception of acceptable methods to achieve a healthy weight, scientific research would probably not occur to such an extent in this area.

## Question 32

| Criteria | Marks |
|---|---|
| • Demonstrates thorough understanding of the peer review process in relation to the advancement of science<br>• Provides links for and/or against peer review process<br>• Links both points to the advancement of science | 6 |
| • Demonstrates sound understanding of the peer review process in relation to the advancement of science<br>• Provides link(s) for and/or against peer review process<br>• Links both point(s) to the advancement of science | 4–5 |
| • Demonstrates a basic understanding of peer review process<br>AND/OR<br>• Provides point(s) for or against peer review process | 2–3 |
| • Provides some relevant information | 1 |

***Sample answer:***

Peer review allows experts in specific fields of scientific research to assess the validity of the research before publication by providing feedback. This process ensures that the research being published is of high quality before it is released to experts. Peer reviewed science allows the experts to build upon the prior research undertaken.

Peer review has identified research that is flawed or based on spurious data before it is published. This prevents erroneous science from being released to the public and the scientists wasting time on further research that does not need to be performed. Hence, scientists can spend their time advancing science in their relevant field based on valid research.

***Answers could include:***

- References to falsified data/research
- Fabricated results
- Fake journal articles
- Availability of experts in field
- Time constraints
- Conflicts of interest.

## Question 33 (a)

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

***Sample answer:***

Large corporations have consistently provided more funding than government and other sources. There was little change in funding between 1980 and 1995. There has been an increase in funding from all sources since 2000. The rate of funding increase is the highest for large corporations.

## Question 33 (b)

| Criteria | Marks |
|---|---|
| • Provides detailed reasons for how funding from large corporations can lead to potential issues<br>• Uses data from the graph to justify the need for regulation | 4 |
| • Outlines how funding from large corporations can lead to potential issues<br>• Identifies the need for regulation | 3 |
| • Identifies how funding from large corporations can lead to potential issues | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

Regulation of funding from large corporations is one way to minimise conflict of interest in research. If the increasing trend in funding continues as shown in the graph, the frequency of misinterpretation, misrepresentation and suppression of research could increase in an attempt to maximise commercial interests. Although researchers will increasingly rely on funding from large corporations, regulations should ensure the integrity of research is maintained.

***Answers could include:***

- Bias
- Inequality in funding
- Commercial pressure.

## Question 33 (c) (i)

| Criteria | Marks |
|---|---|
| • Provides a detailed reason for the impact on world health | 3 |
| • Outlines an impact on world health | 2 |
| • Identifies an impact on world health | 1 |

***Sample answer:***

The purification tablet could kill waterborne pathogens. This would prevent people dying from waterborne diseases and improve the quality of life for a significant number of people without access to clean drinking water.

## Question 33 (c) (ii)

| Criteria | Marks |
|---|---|
| • Provides detailed impacts of both of the conditions of the contract on the design of the investigation<br>• Provides clear links between both the conditions of the contract and the integrity of the investigation<br>• Provides a valid judgement based on the criteria | 7 |
| • Provides impact of both the conditions of the contract on the design of the investigation<br>AND/OR<br>• Provides links between both conditions of the contract and the integrity of the investigation<br>AND/OR<br>• Provides a limited judgement | 5–6 |
| • Outlines impact(s) of the condition(s) to the design of the investigation<br>AND/OR<br>• Links the condition(s) to the integrity of the investigation | 3–4 |
| • Outlines an impact of the contract | 2 |
| • Provides some relevant information | 1 |

***Sample answer:***

The short funding timeframe is not sufficient to demonstrate that the tablet is safe for human consumption. This could lead to the researchers feeling pressure to produce results quickly and not taking time to design experiments that are valid and/or ethical. The researchers would only have a limited amount of time to repeat the experiments to ensure reliability of their results.

Funding constraints should not be placed around sample size. The sample size required is not an arbitrary number and should be carefully determined. Having a small sample size will not be sufficient to guarantee the safety or the efficacy of the tablet.

Overall, the features of the contract will most likely have a negative impact on the integrity of the study.

# 2022 HSC Investigating Science Mapping Grid

**Section I**

| Question | Marks | Content | Syllabus outcomes |
|---|---|---|---|
| 1 | 1 | Mod 5: Practical Investigations to Obtain Primary Data | 12-12 |
| 2 | 1 | Mod 8: Incidents, Events and Science | 12-15 |
| 3 | 1 | Mod 5: Different Types of Scientific Investigations | 12-12 |
| 4 | 1 | Mod 5: Reliability and Validity | 12-2, 12-12 |
| 5 | 1 | Mod 5: Reliability and Validity | 12-2, 12-12 |
| 6 | 1 | Mod 6: A Continuous Cycle | 12-13 |
| 7 | 1 | Mod 7: Reading Between the Lines | 12-5, 12-14 |
| 8 | 1 | Mod 8: Regulation of Scientific Research | 12-15 |
| 9 | 1 | Mod 5: Reliability and Validity | 12-2, 12-12 |
| 10 | 1 | Mod 7: Testing Claims | 12-5, 12-14 |
| 11 | 1 | Mod 7: Impacts on Investigations | 12-3, 12-14 |
| 12 | 1 | Mod 6: Scientific Investigation and Technology | 12-5, 12-13 |
| 13 | 1 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-5, 12-15 |
| 14 | 1 | Mod 7: Impacts on Investigations | 12-2, 12-14 |
| 15 | 1 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-5, 12-15 |
| 16 | 1 | Mod 6: Scientific Investigation and Technology | 12-2, 12-13 |
| 17 | 1 | Mod 5: Different Types of Scientific Investigations | 12-5, 12-12 |
| 18 | 1 | Mod 6: Scientific Investigation and Technology | 12-4, 12-13 |
| 19 | 1 | Mod 6: A Continuous Cycle | 12-6, 12-13 |
| 20 | 1 | Mod 6: A Continuous Cycle | 12-13 |

**Section II**

| Question | Marks | Content | Syllabus outcomes |
|---|---|---|---|
| 21 | 3 | Mod 5: Reporting | 12-7, 12-12 |
| 22 (a) | 3 | Mod 6: Scientific Investigation and Technology | 12-5, 12-13 |
| 22 (b) | 3 | Mod 6: Scientific Investigation and Technology | 12-3, 12-6, 12-13 |
| 23 | 4 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research<br>Mod 6: A Continuous Cycle | 12-7, 12-13, 12-15 |
| 24 (a) | 4 | Mod 7: Testing Claims | 12-4, 12-6, 12-14 |
| 24 (b) | 3 | Mod 7: Testing Claims | 12-5, 12-14 |
| 24 (c) | 2 | Mod 7: Testing Claims | 12-5, 12-6, 12-14 |
| 25 | 5 | Mod 5: Different Types of Scientific Investigations | 12-2, 12-12 |
| 26 | 4 | Mod 6: A Continuous Cycle<br>Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-13, 12-15 |

| Question | Marks | Content | Syllabus outcomes |
|---|---|---|---|
| 27 | 4 | Mod 5: Practical Investigations to Obtain Primary Data | 12-2, 12-12 |
| 28 | 7 | Mod 7: Impacts on Investigations<br>Mod 7: Reading Between the Lines | 12-7, 12-14 |
| 29 (a) | 5 | Mod 6: Scientific Investigation and Technology | 12-2, 12-3, 12-7, 12-13 |
| 29 (b) | 2 | Mod 6: Scientific Investigation and Technology | 12-4, 12-5, 12-13 |
| 30 | 4 | Mod 6: A Continuous Cycle | 12-13 |
| 31 | 4 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-7, 12-15 |
| 32 | 6 | Mod 7: Science as Self-correcting – the issue | 12-14 |
| 33 (a) | 3 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-5, 12-15 |
| 33 (b) | 4 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-15 |
| 33 (c) (i) | 3 | Mod 8: Influence of Economic, Social and Political Forces on Scientific Research | 12-15 |
| 33 (c) (ii) | 7 | Mod 5: Reliability and Validity | 12-2, 12-7, 12-12 |