2019 HSC Investigating Science Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21 (a)

Criteria	Marks
• Provides a correct observation • Relates observation to peptic ulcers	2
• Provides some relevant information	1

Sample answer:

A significant number of gastric tissue samples from patients with peptic ulcers were observed to contain high levels of a specific type of bacteria.

Question 21 (b)

Criteria	Marks
• Provides a correct methodology	4
• Provides a substantially correct methodology	3
• Provides some correct methodology	2
• Provides some relevant information	1

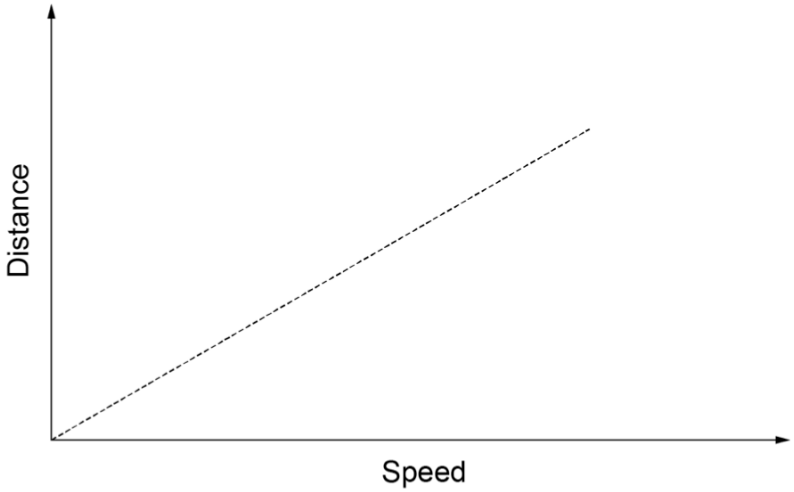
Sample answer:

Spiral bacteria were isolated from peptic ulcer patients.
Marshall was tested for the presence of the spiral bacteria and was found not to have the spiral bacteria.
Marshall ingested the spiral bacteria.
Marshall developed symptoms including nausea and vomiting.
Biopsy showed gastritis and high levels of the spiral bacteria.
Marshall was treated with antibiotics, the spiral bacteria disappeared and the gastritis ceased.

Question 22 (a)

Criteria	Marks
• Shows correct variables on correct axes • Provides correct shape of graph	2
• Shows correct variables and shape of graph OR • Correct speed vs time or distance vs time graph OR • Shows correct variables on correct axes	1

Sample answer:



Question 22 (b)

Criteria	Marks
• Provides a reason why time must be kept constant	2
• States that time must be kept constant	1

Sample answer:

Time is the variable that should be kept constant because distance travelled is proportional to both the speed and the time. In a valid experiment there must only be one independent variable.

Note to markers: No other variables/controls should be accepted eg type of car, road surface, friction.

Question 23

Criteria	Marks
• Provides correct, logical sequence of steps to test the hypothesis, including addressing relevant safety considerations AND factors which ensure validity • Demonstrates how to calculate rate	6
• Provides substantially correct, logical sequence of steps to test the hypothesis, including addressing relevant safety considerations AND factors which ensure validity • Shows some understanding of how to calculate rate	5
• Provides substantially correct, logical sequence of steps to test the hypothesis, including safety considerations AND a factor ensuring validity • Outlines how relevant data is collected to allow rate to be calculated	4
• Provides a sequence of steps, including safety OR validity OR how data is collected	3
• Provides a sequence of steps OR • Addresses safety OR validity OR how data is collected	2
• Provides some relevant information	1

Sample answer:

Choose an effervescent antacid tablet as it is safe to use, non-toxic and safe to handle. The tablets are also all the same size and mass. Antacid tablets produce a visible chemical reaction and so the time taken for the tablet to completely react could be measured.

Add iced water to Beaker 1 and an equal volume of hot water to Beaker 2. Place a tablet in each beaker and use a stopwatch to time how long it takes for the tablets to completely react.

The rate of reaction of the tablets can be determined by dividing the mass of the tablets by the time taken to completely react.

Question 24 (a)

Criteria	Marks
• Provides a testable statement	1

Sample answer:

Using a mobile phone while using a racing car simulation game causes more driving errors.

Question 24 (b)

Criteria	Marks
• Provides TWO relevant problems • Provides a reason why each is a problem	3
• Provides ONE relevant problem • Provides a reason why it is a problem OR • Provides TWO relevant problems	2
• Provides ONE relevant problem	1

Sample answer:

Students used may not have similar experience in the game and therefore testing the effect of the distraction would not be a fair test. The sample size of two students is too small and so the results are unreliable.

Question 24 (c)

Criteria	Marks
• Provides a judgement of relevance with reference to similarities and/or differences between the method and the researcher's aim	3
• Provides a judgement of relevance with reference to a similarity or a difference between the method and the researcher's aim OR • Provides similarities and/or differences between the method and the researcher's aim	2
• Identifies a relevant feature of the method or the researcher's aim	1

Sample answer:

Processing visual information and hand-eye coordination are features common to the simulation and driving. Hence testing for the effect of texting on driving in a simulator may be applicable to driving, therefore indicating the method could be relevant. However, the absence of real consequences when using the simulator may make the method less relevant to a real driving experience.

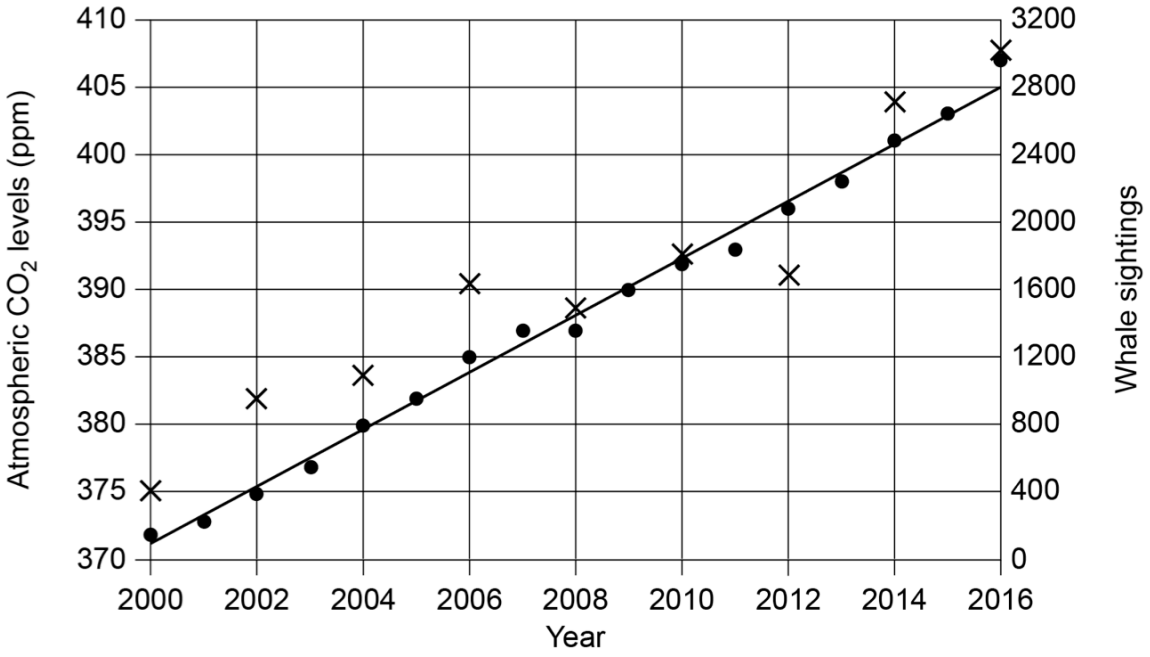
Question 25 (a)

Criteria	Marks
• Provides an appropriate straight line of best fit • LOBF has approximately 50% of points above and below • Line cannot just join first and last data points	1

Question 25 (b)

Criteria	Marks
• Plots points correctly with appropriate scale	2
• Plots some points correctly OR • Appropriate scale given	1

Sample answer (a) and (b):



Question 25 (c)

Criteria	Marks
• Provides a plausible inference • Relates inference to data from the graph	2
• Provides a plausible inference OR • Provides relevant information from graph	1

Sample answer:

From the graph both carbon dioxide concentration and whale sightings increased in a similar manner over the time period. Therefore, it could be inferred that increased numbers of whales cause an increase in atmospheric carbon dioxide.

Question 25 (d)

Criteria	Marks
• Identifies TWO factors that show a correlation • Provides a reason why it was thought that there was a cause and effect relationship • Clearly indicates a lack of valid causation	4
• Identifies TWO factors that show a correlation • Provides a reason why it was thought that there was a cause and effect relationship OR • Identifies TWO factors that show a correlation • Clearly indicates a lack of valid causation	3
• Demonstrates some understanding of a cause and effect relationship	2
• Provides some relevant information	1

Sample answer:

It was observed that glass panes in old buildings, many hundreds of year old, were thicker at the bottom than at the top. It was thought this was caused by the glass slowly flowing downwards as a fluid, due to gravity. It is now known that this is a correlation, but not a causation, as glassmakers would orient the thicker section of glass at the bottom to better support the weight of the window.

Question 26

Criteria	Marks
• Identifies gases or other nutrients as being necessary for plant growth • Provides, with some detail, a process to correct an identified flaw	3
• Identifies a flaw in the experiment • Identifies ONE variable that needed to be measured OR • Identifies gases or other nutrients as being necessary for plant growth • Identifies a flaw in the experiment OR • Outlines a way to correct an identified flaw	2
• Identifies a flaw OR • Identifies a variable to measure OR • Identifies gases involved	1

Sample answer:

Van Helmont did not realise that gases were used and produced by growing plants so could not measure them at the time.

Since we now know that plant growth involves photosynthesis, scientists today would accurately measure the total mass of the gases (carbon dioxide and oxygen) throughout the experiment. This would be compared to the initial and final masses of the plants.

Question 27 (a)

Criteria	Marks
• Provides the specific medicinal use of an identified plant used by Aboriginal or Torres Strait Islander Peoples	2
• Identifies a plant OR • Provides a medicinal use	1

Sample answer:

The crushed leaves from tea-trees were used as a paste to treat infections.

Question 27 (b)

Criteria	Marks
• Identifies an Australian plant • Provides information that relates this plant to a new drug treatment	2
• Identifies an Australian plant currently or with potential to be used medicinally	1

Sample answer:

An Australian plant (species 8473) is being investigated by QUT. It was found that chemicals in this species are a potential treatment for the dengue fever.

Question 28

Criteria	Marks
• Provides detailed examples of misrepresentation and/or misinterpretation and/or suppression • Describes issues associated with the misuse of scientific evidence • Produces a logical, coherent discussion of the issues	7
• Provides examples of misrepresentation and/or misinterpretation and/or suppression • Describes issue(s) associated with the misuse of scientific evidence	5–6
• Provides example(s) of misuse • Describes issue(s) associated with the misuse of scientific evidence	3–4
• Provides relevant example(s) OR • Outlines issue(s) associated with the misuse of scientific evidence	1–2

Sample answer:

There was a conflict between the tobacco industry and knowledge of tobacco's link to lung cancer. If it became widespread public knowledge, large amounts of revenue could be lost by the companies and there could be potential litigation for compensation from victims. This led the tobacco industry to misrepresent and suppress the scientific evidence.

The tobacco industry misrepresented information about lung cancer. For example, in the 1950s, a group of tobacco companies such as Phillip Morris, Brown and Williamson stated that 'there is no conclusive scientific proof of a link between smoking and cancer. Medical research points to many possible causes of cancer.' This was published in hundreds of newspapers across America. There was a deliberate conspiracy between tobacco companies to misrepresent the data.

In addition, scientific evidence was suppressed. For example, the research division for the RJ Reynolds tobacco company was shut down in 1970 by the company's legal department in order to prevent further research when it appeared that there may be a link between smoking and lung cancer.

Question 29 (a)

Criteria	Marks
• Correctly identifies the requirement	1

Sample answer:

The person would need to be an expert in the field.

Question 29 (b)

Criteria	Marks
• Provides positive effects of peer review on the advancement of science • Includes a specific example	4
• Provides a positive effect of peer review on the advancement of science • Includes a specific example OR • Provides positive effects of peer review on the advancement of science OR • Provides positive effects of peer review • Includes a general example	3
• Provides a positive effect of peer review on the advancement of science OR • Outlines an example	2
• Provides some relevant information	1

Sample answer:

Peer-review establishes whether an investigation, its results and conclusions are valid. It permits researchers in the field to provide suggestions to the author to improve their experiment prior to publication. This allows the field of science to be advanced in that it promotes the production of accurate information and helps to reduce the effects of predatory journals. For example, Marshall and Warren's paper was peer-reviewed prior to its publication in The Lancet which helped to advance the field of biology and changed the way in which peptic ulcers are treated.

Question 30 (a)

Criteria	Marks
• Names an appropriate river • Identifies both a positive and a negative factor involved	2
• Names an appropriate river OR • Identifies a positive and negative factor	1

Sample answer:

Name of river: Franklin River	
Positive aspect of damming	*Negative aspect of damming*
It would provide hydroelectricity	Flooding would destroy a number of organisms and their habitats

Question 30 (b)

Criteria	Marks
• Identifies issues in detail that relate to the damming project • Outlines links between these issues and the public image of science • Draws out implications of these issues	4
• Identifies issue(s) relating to the damming project • Identifies a link between the issue(s) and the public image of science	3
• Identifies some issues relating to a damming project OR • Identifies a link between an issue and the public image of science	2
• Provides some relevant information	1

Sample answer:

The project to dam the Franklin River polarised the population, and scientific information allowed those that were undecided to choose whether to accept or reject the science behind the project.

For those that did not support the damming, the public image of environmental science was improved, since environmental information was provided by scientists, rather than just economic factors being considered. This showed the negative impacts that would result from damming the river. The consequence was that the High Court was persuaded by the scientific arguments, and upheld the public image of science.

For those that did support the damming, it lowered the public image of science, as the scientific opinion went against economic and industrial progress. Some supporters of the project tried to belittle scientists and suggest that the science was wrong or misinformed.

Question 31

Criteria	Marks
• Identifies both phenomena • Provides details demonstrating understanding of the application of each phenomenon in new telescope technology	4
• Identifies both phenomena • Shows some understanding of the application of each phenomenon in new telescope technology	3
• Identifies a phenomenon • Shows some understanding of the application of this phenomenon in telescopes	2
• Provides some relevant information	1

Sample answer:

Phenomenon A is reflection.
Phenomenon B is refraction.

Modern reflecting telescopes can make use of both phenomena. A laser can be shone through the atmosphere. The atmosphere refracts the laser beam. The distortion this produces can be monitored and used to correct for atmospheric distortion of light entering the telescope. This can be done by rapidly changing the shape of the telescope's mirrors. Light entering the telescope strikes the mirrors, and the adaptive optics cause the reflected light to be focused on the detector.

Question 32

Criteria	Marks
• Identifies a device • Outlines its applications including examples • Outlines a positive and negative impact of its use • Provides an evaluation and supports it with evidence	6
• Identifies a device • Outlines its application(s) • Outlines a positive AND/OR negative impact of its use • May include an evaluation	4–5
• Identifies a device and an application OR • Identifies a device and outlines an impact of its use	2–3
• Provides some relevant information	1

Sample answer:

An endoscope is composed of a small camera on a flexible lead that can be used in many locations, including being inserted via a patient's mouth and used to observe the digestive tract for ulcers. Some endoscopes are only for observations, while others can be used to complete the surgery eg to remove polyps. The impact of this device is that it has led to reduced morbidity and mortality resulting from diagnostic surgery, since it is much less invasive and leads to faster recovery.

Negative impacts include transfer of infections if the device is not sterilised, and internal perforations leading to complications such as infections and death.

Overall, the positive impacts of the endoscope outweigh the negative impacts, thus endoscopes have been beneficial to human health.

Question 33 (a)

Criteria	Marks
• Provides a current example • Links the example to the ethical issue • Provides a reason for it being an ethical issue	3
• Identifies an ethical issue in scientific research OR identifies an example • Identifies why it is an ethical issue	2
• Identifies an ethical issue OR identifies an example	1

Sample answer:

Scientific research into new pharmaceuticals can lead to ethical issues. For example, medical trials will often involve giving some patients a placebo and other patients the drug being trialled. Patients need to consent to the trial, otherwise it could be considered unethical to give a patient a placebo, since it is known that it will not help the patient.

Question 33 (b)

Criteria	Marks
• Outlines a protocol/code of conduct • Provides an evaluation of the effectiveness of the protocol/code of conduct • Supports evaluation with evidence	3
• Outlines a protocol/code of conduct • Provides a limited evaluation	2
• Outlines a protocol/code of conduct	1

Sample answer:

Legislation is a very effective protocol that must be adhered to, for example, the NSW Animal Research Act 1985. This Act states that the welfare of the organisms to be experimented on must be considered before the research is conducted. Prior to 1985 it was acceptable practice for schools to raise mice for dissections. After the legislation was enacted, this was no longer permitted and does not occur in schools in NSW. Thus, the legislation has been very effective.

Answers could include:

International treaties eg Nuremburg Code.
Guidelines provided by scientist's employer.

Question 34

Criteria	Marks
• Outlines an impact of government • Outlines an impact of a large corporation • Provides specific examples • Relates the examples to the implications for scientific research • Produces a logical, coherent analysis	7
• Outlines an impact of government • Outlines an impact of a large corporation • Provides an example • Relates the example to the implications for scientific research	5–6
• Outlines an impact of government OR a large corporation • Provides an example • Relates the example to the implications for scientific research OR • Outlines an impact of government AND large corporation • Provides an example	3–4
• Identifies an impact of government AND/OR large corporation AND/OR provides an example	1–2

Sample answer:

Grants, for example from the Australian Research Council (ARC), can be provided by the government to allow research to occur. The government funding may be skewed towards those projects that have immediate applications to Australia. For example, Discovery Projects from the ARC require Benefit and Impact Statements and encourage impacts such as broader job creation. An implication is that this may mean less funding for pure research.

Large corporations have extensive budgets and can invest billions of dollars into a project. The Monsanto company, along with government money from Japan, China, USA, India committed money to IRGSP – International Rice Genome Sequencing Project. This may have far-reaching consequences for biotechnology allowing better rice production worldwide.

However, the use of funding from large pharmaceutical companies may lead to favouring of studies that are from pharmaceutical-sponsored research. A review by Sydney University in 2017 found that industry-sponsored studies are more likely to favour products such as pharmaceuticals and medical devices than non-industry funded research. This suggests there is bias in pharmaceutical-sponsored research that may influence the use of a product.

Answers may include:

Money provided by government can vary greatly between countries. For example, the government in China allocates a large proportion of the budget to scientific research, while this proportion is lower in Australia.

Governments can form particular governing bodies or committees that can promote or demote a particular area of scientific research.

[A response that relates to tobacco industry cannot score anything for discussing large corporations, but could access up to 4 marks for government impact.]

2019 HSC Investigating Science Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 7 Evidence-based analysis	INS12-14
2	1	Mod 6 A continuous cycle	INS12-13
3	1	Mod 5 Reporting	INS12-12
4	1	Mod 6 A continuous cycle	INS12-4, 12-13
5	1	Mod 8 Incidents, events and science	INS12-15
6	1	Mod 6 Scientific investigation and technology	INS12-2, 12-13
7	1	Mod 5 Reliability and validity Mod 7 Testing claims	INS12-5, 12-12, 12-14
8	1	Mod 7 Reading between the lines	INS12-5, 12-14
9	1	Mod 7 Testing claims	INS12-5, 12-14
10	1	Mod 7 Reading between the lines	INS12-6, 12-14
11	1	Mod 5 Different types of scientific investigations	INS12-6, 12-12
12	1	Mod 6 A continuous cycle	INS12-4, 12-13
13	1	Mod 5 Reliability and validity	INS12-12
14	1	Mod 5 Student investigations	INS12-3, 12-12
15	1	Mod 8 Regulation of scientific research	INS12-15
16	1	Mod 6 Scientific investigation and technology	INS12-13
17	1	Mod 7 Testing claims	INS12-6, 12-14
18	1	Mod 5 Reporting	INS12-5, 12-6, 12-12
19	1	Mod 5 Different types of scientific investigations	INS12-6, 12-12
20	1	Mod 6 Scientific investigation and technology	INS12-5, 12-13

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	2	Mod 5 Practical investigations to obtain primary data	INS12-1, 12-12
21 (b)	4	Mod 5 Practical investigations to obtain primary data Mod 7 Testing claims	INS12-1, 12-12, 12-14
22 (a)	2	Mod 6 Scientific investigation and technology	INS12-4, 12-7, 12-13
22 (b)	2	Mod 5 Student investigation	INS12-2, 12-12
23	6	Mod 6 Scientific investigation and technology	INS12-2, 12-4, 12-7, 12-13
24 (a)	1	Mod 5 Student investigation	INS12-1, 12-12
24 (b)	3	Mod 5 Reliability and validity	INS12-2, 12-12
24 (c)	3	Mod 5 Reliability and validity	INS12-2, 12-12
25 (a)	1	Mod 5 Reliability and validity	INS12-4, 12-5, 12-12
25 (b)	2	Mod 5 Reliability and validity	INS12-4, 12-12
25 (c)	2	Mod 5 Reliability and validity	INS12-5, 12-7, 12-12
25 (d)	4	Mod 7 Evidence-based analysis	INS12-5, 12-6, 12-14

Question	Marks	Content	Syllabus outcomes
26	3	Mod 5 Practical investigations to obtain primary data Mod 5 Reliability and validity	INS12-2, 12-12
27 (a)	2	Mod 6 A Continuous cycle	INS12-13
27 (b)	2	Mod 6 A Continuous cycle	INS12-13
28	7	Mod 7 Reading between the lines Mod 8 Influence of economic, social and political forces on scientific research	INS12-3, 12-7, 12-14, 12-15
29 (a)	1	Mod 5 Different types of scientific investigations Mod 7 Reading between the lines	INS12-12, 12-14
29 (b)	4	Mod 5 Different types of scientific investigations Mod 7 Reading between the lines	INS12-7, 12-12, 12-14
30 (a)	2	Mod 8 Incidents, events and science	INS12-15
30 (b)	4	Mod 8 Incidents, events and science	INS12-6, 12-7, 12-15
31	4	Mod 6 A continuous cycle	INS12-13
32	6	Mod 8 Influence of economic, social and political forces on scientific research	INS12-7, 12-15
33 (a)	3	Mod 8 Regulation of scientific research	INS12-15
33 (b)	3	Mod 8 Regulation of scientific research	INS12-6, 12-15
34	7	Mod 8 Influence of economic, social and political forces on scientific research	INS12-7, 12-15