2020 VCE Environmental Science examination report

General comments

In 2020 the Victorian Curriculum and Assessment Authority produced an examination based on the *VCE Environmental Science Adjusted Study Design for 2020 only*. The examination provided students with the opportunity to demonstrate and apply a range of knowledge and skills.

In a difficult year for many students, the overall standard of exam responses was quite high; students and teachers should be congratulated on their persistence and hard work in preparing for this exam. There was a solid knowledge of biodiversity concepts and an understanding of issues related to energy use, greenhouse gases and global warming.

There are some basic concepts that students need to write about more clearly and correctly to improve the standard of their responses. These include:

- understanding of the greenhouse gas concept around the absorption of re-radiated (not incoming) infra-red radiation to transfer energy to greenhouse gases in the atmosphere
- understanding that the ozone layer does not contribute to global warming (there is still some incorrect scientific understanding around the hole in the ozone layer)
- the difference between a 'control' and 'controlled variables' in an experiment.

Some responses would also be improved by reading the question more carefully and only responding to what is being asked for. This also includes only giving the number of examples asked for – if only one example is required, give one, not two or three as the first response provided is the one that is assessed.

Specific information

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

Question	% A	% B	% C	% D	Comments
1	93	2	4	1	
2	0	8	25	67	A 'seed bank' would be used to specifically store seeds for use in maintaining genetic diversity, so the correct response was D. A broader 'gene bank' might store genetic material such as seeds (as well as plant cuttings, root stock, plant material etc.), which may be why some students incorrectly chose C.
3	24	3	10	62	A is correct because it is an international agreement, although 62 per cent of

Question	% A	% B	% C	% D	Comments
					students chose D, which is a piece of environmental legislation produced by the Federal Government.
4	81	1	14	4	
5	14	55	16	14	The silvereye is only found on Lord Howe Island and cannot move elsewhere to escape predators, so they have a restricted geographic range.
6	2	10	7	82	
7	2	12	73	14	A key word in the question is 'alone'. While small appearance variations in morphology give some indication, further genetic studies would provide additional evidence of genetic diversity.
8	83	7	5	6	
9	4	59	31	6	During periods conducive to the formation of coal (Carboniferous and the later Cretaceous), coal could form in a few million years; hence C is the best answer. The most common incorrect answer was B (100 million years), presumably confusing how long coal takes to form and how long ago it formed.
10	1	0	1	98	
11	6	77	9	9	
12	9	4	77	10	
13	2	4	64	29	According to the data in the table, diesel produces 3.2 kg of CO_2, compared to the other fuel types, all of which are less. A common incorrect answer was D, presumably due to reading the CO_2 emissions column rather than the energy content column.
14	4	8	33	55	
15	38	55	5	3	This question required an understanding of the various scientific terms used and a correct knowledge of the meaning of precision. Because there was close agreement within multiple results, this indicated a high degree of precision. A common incorrect response was C; close agreement within the results could still occur with or without bias in the experiment. Bias would affect the accuracy of results, not necessarily precision.
16	8	2	7	83	
17	8	82	7	3	
18	81	1	12	6	
19	54	3	2	41	A role of the Environment Protection Authority (EPA) and Department of Health and Human Services (DHHS) is to help determine and enforce regulatory frameworks. A common incorrect response was D, which did not account for the reference to 'standards set by developers'. The EPA and DHHS are concerned with setting government water quality standards, not the individual developers.
20	2	7	86	6	
21	55	15	17	12	This question required students to compare the rates of temperature increase and decrease shown on the graph. The time taken to rise to a high point (an interglacial

Question	% A	% B	% C	% D	Comments
					period) from a low point (glacial period) is less than it takes for similar decrease, so A is the best response.
22	82	8	3	7	
23	11	64	15	10	It would be assumed that the air collected in 2020 will contain more CO_2 than air collected in 1800 because of the increase in fossil fuel burning since the beginning of the industrial revolution. Hence, there would be a slightly larger temperature rise in 2020 than 1800 (answer B). There would be little or no temperature rise with oxygen and a higher rise with pure carbon dioxide. There was no obvious pattern in the incorrect responses.
24	6	25	6	63	Infra-red radiation is absorbed in the lower atmosphere by water vapour and CO_2 (both incoming and outgoing). The Sun emits strongly in the infra-red, but much of this is absorbed by water vapour in the lower atmosphere, hence line C is infra-red. Since there is almost no water vapour in the upper atmosphere (it is too cold), infra-red is not absorbed there. Visible light is absorbed by Earth's surface and re-radiated as infra-red, which is absorbed in the lower atmosphere, hence line E is also infra-red. Therefore, lines C and E are infra-red, so option D is the correct response.
25	4	37	40	19	There are random variations in temperature (weather) from year to year. Trends can only be detected by taking a much larger period and averaging this data. Hence, the period 1986–2005 was taken as baseline. The most common incorrect response was C: greenhouse gases are increasing in the atmosphere, which is a correct statement but doesn't correspond to the question asked.
26	3	4	48	46	There is a large amount of uncertainty in climate models. Their predictions depend on, among other things, the data inputted, which can never be complete. Much of the mechanisms are poorly understood. Hence, good models give a range of probable predictions, making option D the best response. The most common incorrect response was C. While C is a true statement, it is not the reason for providing a range.
27	5	25	8	62	The natural greenhouse effect, largely due to water vapour, maintains the temperature on Earth at a level at which life can exist: that is, at a higher temperature than would otherwise exist.
28	19	8	3	70	Carbon sequestration involves removing carbon (in the form of carbon dioxide) out of the atmosphere and sequestering it elsewhere – in plants, underground, in water etc. Hence, planting trees provides a sink for caron dioxide. A common incorrect response was burning biofuels, which adds carbon dioxide (and often methane) to the atmosphere.
29	4	16	64	16	'Scientific uncertainty' means that there is a range of possible values within which the true value of the measurement lies, based on the mechanism of the experiment or observation. A major factor will be the limitations of the measuring equipment, among other factors. The limitations of the experimenter – which very few students chose – contributes to mistakes (personal errors) that do not form part of the analysis of scientific uncertainty.
30	52	14	21	14	

Section B

Question 1a.

Marks	0	1	2	3	Average
%	3	5	17	75	2.6

The use of basic mathematical skills allowed most students to correctly calculate a Simpson's Index figure of 0.802 for full marks. Showing the working in the table allowed students to get part marks for making minor mistakes in the calculation of the index.

Question 1b.

Marks	0	1	2	Average
%	4	8	88	1.8

By looking at the Simpson's Index figures across the three years, students were usually able to identify that there was a clear decreasing or downward trend in diversity over this 20-year period. Using the data was an important part of the answer, and most students described that from 1995 (with a Simpson's Index of 0.833) it dropped down to 0.802 in 2005 and then another decrease, down to 0.765 by 2015.

Question 1c.

Marks	0	1	2	3	Average
%	16	25	41	18	1.6

Many students were unable to correctly explain the term 'accuracy'. Higher scoring responses mentioned that scientific accuracy relates to the closeness of the result to 'true' or 'scientifically determined' results or values of an experiment. Responses that did not score well discussed ideas around scientific bias, reducing errors or precision (by discussing the idea of trying to get results that are close together each time the experiment is conducted).

In order to improve the accuracy of the results, students needed to give two relevant ideas that would mean that the results were as close as possible to the true value of diversity at the rural location.

Acceptable responses included:

- sampling from multiple sites, over multiple years

- increasing the number of weeks data was collected

- increasing the number of traps/observations recording insect numbers.

Question 1di.

Marks	0	1	2	Average
%	13	21	65	1.5

There was some confusion in the way some students described the mark-recapture sampling process. Marks were awarded for describing the basic method as capturing the mammals with traps or nets and marking or tagging these individuals, which are then released and at some later point the capture process is repeated. Population size can be calculated based on the numbers captured against the numbers re-captured with the

mark/tag. Responses that did not score highly incorrectly discussed the idea that the mammals were captured, marked in some way (sometimes with a tracking device) and then monitored over time.

Question 1dii.

Marks	0	1	2	Average
%	14	8	78	1.6

In theory it could be possible to capture, mark, release and re-capture certain insect species, but this method is generally not suitable and unlikely to be used. Higher scoring responses understood this and explained why the method is too difficult to apply to insect populations. Factors such as the abundance of insects, diversity in species, small size of organisms, short lifespan and wide geographical range of insects would make marking and re-capture extremely difficult and ineffective.

Question 1e.

Marks	0	1	2	Average
%	9	15	77	1.7

Most students correctly identified one of two key ways that insects are of benefit to ecosystems. They either:

- explained the role insects play as pollinators, playing a key role in plant life cycles or as a food source for other animals in providing an energy source through food webs
- discussed the role insects play in breaking down organic material from dead plants and animals, more correctly describing them as detritovores.

The question required only one example, and responses that did not score well generally tried to list a few different ideas.

Question 1f.

Marks	0	1	2	Average
%	26	39	35	1.1

Some students were able to explain a strategy relevant to using targeted pesticides to kill or prevent the reproduction of insect pests in agricultural areas. 'Targeting' refers to the use of pesticides that do not kill native, endangered or rare insects but only kill specific pest species that have a negative impact on the farming process. This could also mean less widespread spraying of pesticides by using it only in specific target areas (such as on specific crops or paddocks). By using less pesticide, there is less likelihood of affecting important beneficial insects throughout an ecosystem and maintaining biodiversity.

Question 2a.

Marks	0	1	2	Average
%	17	57	26	1.1

Overall, this question was not well answered, with many students either focusing on the healthy animal population or the injured animals, rather than both. Higher scoring responses were able to comment on the need to provide care for injured animals while allowing healthy animals to continue to exist in the wild. They may continue to survive (unlike injured individuals) and can repopulate the existing habitat as it recovers.

Question 2b.

Marks	0	1	2	3	Average
%	26	13	27	34	1.7

Students were asked to outline one technique that is employed by conservationists to ensure the genetic diversity of a species is maintained after the removal of individuals from a population. Most students focused their responses on the removed, injured animals and their rehabilitation in captivity. Once their health is regained, they could be involved in a captive breeding program and/or returned to the wild. The reintroduction would either maintain or increase genetic diversity by increasing total population numbers and increasing the number of possible mates. This increases the variety of genetic material and helps ensure inbreeding does not occur.

Question 2c.

Marks	0	1	2	3	Average
%	25	11	31	33	1.7

A variety of possible conservation techniques (different to the technique described in Question 2b.) were suggested and linked to how biodiversity could be promoted. Many students described a habitat restoration program, after the volcanic eruption, by careful replanting of native vegetation. Other responses explained the translocation of some individuals to a safe site to allow for breeding opportunities, the creation of wildlife corridors to link separate populations, or the creation of gene banks to store genetic material, which could be used later to increase the genetic diversity of populations within the ecosystem.

Question 2d.

Marks	0	1	2	Average
%	15	28	57	1.4

Nearly all students understood that the loss of the paradise parrot was not an example of mass extinction. They were able to justify this point by explaining that mass extinction involves the loss of a large percentage of the world's species over a short period of time rather than the loss of a single species.

Question 2e.

Marks	0	1	2	Average
%	28	54	18	0.9

In general, students were able to correctly identify the conservation category the paradise parrot would have been assigned to just prior to the extinction as critically endangered. However, not all were able to clarify this with the correct reasoning. This should have been based on the idea that the parrot population was facing an extremely high risk of extinction in the immediate future. Some students tried to indicate that the population may have been classified as 'extinct in the wild' if there were some individuals surviving in a captive breeding program.

Question 3a.

Marks	0	1	2	3	4	5	Average
%	13	9	28	38	11	1	2.3

This question required students to write a longer, coherent response based on the information provided about the case study and using key ecologically sustainable development (ESD) principles. In this example the proposal to repair and increase the height of the seawall should have been seen as meeting ESD principles by using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased.

Students needed to make clear the meaning of both the principles indicated – intergenerational equity and conservation of biodiversity and ecological integrity – by relating them to the situation with the beach, dune system, marine reserve and the community living in the township.

Most students just concentrated on these two principles and did not always clearly or fully link the definitions of these terms to the case study or the broad meaning of ESD. Responses that did not score well also incorrectly split conservation of biodiversity and ecological integrity into two separate principles. Higher scoring responses made the meaning of ESD and both principles clear, related these to the issues raised in the case study and often included the idea of trying to balance economic, social and environmental issues when considering management and development plans.

Question 3b.

Marks	0	1	2	3	Average
%	66	5	14	15	0.8

The second proposal (i.e. to do nothing because it may be costly to repair the seawall and the impacts of beach erosion are not fully understood locally) is clearly related to the 'precautionary principle'. Not many students correctly identified this principle or made the meaning clear in their discussion. The second proposal was an incorrect approach – there were clearly already threats of serious or irreversible damage to the beach and dune system, so a lack of full scientific certainty should not have been used as a reason for postponing cost-effective measures to prevent this environmental degradation. Based on this principle, the lack of knowledge about potential impacts of erosion/sea level rising or not believing in climate change should not be used as arguments for doing nothing to fix the wall/protect the dune system and town from rising sea levels in the future.

Question 3c.

Marks	0	1	2	Average
%	33	54	13	0.8

There was a lack of clarity in many responses to this question about the steps involved in the risk assessment process. Once potential risks are identified, the next steps are to analyse and determine the level or scale of these risks related to the various environmental proposals. This could include evaluating the likelihood of each risk occurring and the acceptability of this happening. Most students missed this first step but did identify the next part of the process in developing a management plan to deal with these potential risks and reduce hazards occurring. Other responses added in the idea of ongoing assessment and monitoring of risk as part of the process.

Question 3d.

Marks	0	1	2	Average
%	13	24	64	1.5

Most students were able to correctly identify one health and safety concern and one ethical concern. Higher scoring responses related their concerns to the case study (i.e. environmental science students investigating a marine ecosystem in the field) rather than general points such as wearing safety glasses and a lab coat. Key health and safety concerns related to taking care and precautions against exposure to heat/sun/wind/rain, precautions and protection against dangerous organisms (snakes, blue-ringed octopus etc.), or care when in or near the water (waves, currents). Ethical concerns focused on the care taken with handling and identifying marine species – for example, not taking samples out of the water, handling them too much, disturbing them during breeding season.

Question 4a.

Marks	0	1	2	Average
%	28	45	27	1.0

The major environmental disadvantage students should have identified is that when natural gas undergoes combustion, carbon dioxide is produced and released into the atmosphere. Carbon dioxide is a major greenhouse gas that contributes significantly to global warming. Responses that did not score well described natural gas as a non-renewable energy source.

Question 4b.

Marks	0	1	2	Average
%	43	3	54	1.1

To calculate the number of wind turbines required to produce 50 MW, most students correctly multiplied 50 by 1000 (to convert MW into kW), which gave 50 000 kW, and then divided this by 500 kW to get the answer 100. Students were asked to show their working to explain the answer of 100 turbines.

Question 4c.

Marks	0	1	2	3	4	Average
%	4	4	22	20	50	3.1

The majority of students were able to correctly identify two key disadvantages involved in the construction of a large-scale windfarm, although some did not always explain these disadvantages clearly. Acceptable ideas included that relying on wind is a problem because of the intermittent nature of the source. If the wind is not blowing, the island's residents will need a storage or back-up energy system. Other high-scoring responses focused on the need to build 100 wind turbines, which would mean high infrastructure costs and major visual and/or noise impacts, which can have a negative effect on human health for those living nearby. Some students also described the impact on bird life if the turbines disturb flight paths and kill birds who fly into blades.

Question 5a.

Marks	0	1	2	Average
%	44	37	19	0.8

Overall, students did not have a very good understanding of the term 'global warming potential'. Students with higher scoring responses were able to explain the concept of 'global warming potential' by referring to a particular greenhouse gas and its total contribution to global warming resulting from the emission of one unit of that particular gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of one. Vague answers indicated that the 'global warming potential' of a particular greenhouse gas refers to the ability of the gas to absorb re-radiated energy.

Question 5b.

Marks	0	1	2	Average
%	32	32	36	1.0

Most students were able to indicate that a unit of sulfur hexafluoride had a much greater impact on global warming compared to a unit of nitrous oxide. By dividing 23 500 by 265, higher scoring responses indicated that a unit of sulfur hexafluoride traps approximately 89 times more heat energy than a unit of nitrous oxide.

Question 5c.

Marks	0	1	2	Average
%	23	58	18	0.9

Overall, this question was not well answered, as many students did not make a clear link between the amount of individual greenhouse gases being released into the atmosphere and their contribution to global warming. While a single unit of sulfur hexafluoride will trap more re-radiated infra-red energy than a unit of these other gases, the total volume of sulfur hexafluoride being released into the atmosphere annually is much lower than these other gases. Therefore, because carbon dioxide, methane and nitrous oxide are released in much greater amounts, they contribute more to the total amount of heat energy being trapped in the atmosphere and make a greater overall contribution to the rate of global warming.

Question 6a.

Marks	0	1	2	Average
%	31	40	29	1.0

Students needed to clearly explain that the concept of 'peak oil' refers to the point where maximum oil production is reached, which is then followed by a steady, rapid decline. They then needed to link this to the data in the graph by referring to either of the two scenarios. A peak of around 30 Gb/year was predicted for 2010 by one model and another of around 32 Gb/year for 2020 in the other scenario. Responses that did not score well either did not refer to the decline after the peak is reached or did not refer to data from the graph.

Question 6b.

Marks	0	1	2	Average
%	39	11	50	1.1

This question clearly asked about the possible negative environmental impacts from the extraction and transport of crude oil from wells and offshore oil rigs. Therefore, higher scoring responses made clear the potential impacts from oil spills into the marine environment, which may create slicks that kill or harm seabirds, mammals and other species, or oil spills into water supplies polluting drinking water or polluting land-based ecosystems. Responses that did not score well unsuccessfully tried to discuss the environmental impacts of burning oil/petrol as a fossil fuel (and therefore global warming impacts). The question was about extraction and transport of crude oil, not burning it as a fuel after it is refined.

Question 7a.

Marks	0	1	Average
%	18	82	0.8

Based on the data in the table, the three warmest years globally since 2000 (from highest to lowest) were 2016, 2017 and 2015. Most students were able to correctly list these years in order.

Question 7b.

Marks	0	1	2	Average
%	38	54	8	0.7

Overall, this question was not well answered. Many students were unable to state two clear reasons why the warmest year since 2000 recorded in the city did not occur in the same year as the warmest year globally. Ideas were jumbled together or included incorrect statements related to a build-up of greenhouse gases being released from the city causing a local greenhouse effect. Higher scoring responses made clear points related to climate variability on a global scale or regional weather influences caused by geographical features or ocean temperature changes. Some students correctly identified regional influences on climates such as El Niño and La Niña.

Question 7c.

Marks	0	1	2	Average
%	32	32	35	1.0

Students needed to correctly identify that Charlotte's arguments were not valid scientific comments. Most did so but could not always make clear why the comment that 'global temperature data does not show a warming trend as 2018 was cooler than 2017' was incorrect. Better answers identified the key issue: to describe a trend in climate data, you need to look at changes over much longer periods than one year for a valid assessment.

Question 7d.

Marks	0	1	2	Average
%	16	53	31	1.2

Most students were able to identify one of the key reasons for global sea levels rising, which is the heating and melting of land-based ice. Land-based ice refers to ice caps, ice sheets and glaciers, rather than ice shelves and icebergs. Not all students were able to correctly identify the second reason related to the thermal expansion of the oceans. As sea water heats up, it becomes less dense and takes up more volume (rather than water molecules getting bigger as some responses stated). Other responses discussed increasing global rainfall contributing to sea levels rising.

Question 7e.

Marks	0	1	2	3	Average
%	11	13	15	61	2.2

From the list of four options, most students were able to correctly identify the two impacts of the enhanced greenhouse effect as being the loss of species, and more frequent and longer heat waves. These were the only two relevant impacts, and higher scoring responses went onto to explain their impacts. Ideas focused on species loss due to an inability by organisms to adapt to environmental changes due to climate change, and heat waves due to rise in annual average global temperatures, changing weather patterns and causing less rainfall in some regions and drought.

Question 8a.

Marks	0	1	2	Average
%	49	50	1	0.5

Most students did not focus on the question, which referred to the period between 1000 and 1800 and why global methane levels had remained relatively steady during this time. Most responses that did not score well discussed issues related to the growth of industrialisation post-1800 and the rise in the use of fossil fuels. The focus of high-scoring responses was on the relatively low and steady population at this time with limited agricultural production and no industrialisation. This meant a more natural balance was occurring between the addition and removal of the methane gas into and from the atmosphere. Few students made the link between the even input (sources) and outputs (sinks) of atmospheric methane.

Question 8b.

Marks	0	1	2	Average
%	83	4	13	0.3

By correctly reading the figures from the graph, students identified the 1800 concentration of approximately 730 ppb and the 2020 concentration of approximately 1860 ppb. To calculate the percentage change, 730 is subtracted from 1860 to give 1130. This was divided by 730 and multiplied by 100 to give a percentage answer of approximately 155 per cent. Few students were able to give a figure between 150 and 160 per cent given the scale of the graph.

Question 8c.

Marks	0	1	2	Average
%	25	53	22	1.0

Students were required to list two sources that have led to an increase in atmospheric methane since 1800. Higher scoring responses gave key sources such as rice farms, sewage treatment works, agriculture production including livestock farming, landfills, biomass burning or the melting of permafrost. Many students incorrectly identified the burning of fossil fuels as a source of atmospheric methane.

Question 8d.

Marks	0	1	2	Average
%	18	53	29	1.1

Most students recognised that the major impact the increase in atmospheric concentration of methane has had on global temperature is a contribution to global temperature rising (global warming). Not all responses made the reason for this impact clear – methane is a greenhouse gas, which absorbs re-radiated infra-red radiation or heat. It is expected that students at this level understand that it is re-radiated infra-red energy from Earth's surface that is absorbed by methane (and other greenhouse) gas molecules. It is not scientifically accurate enough to state that the gas 'traps', 'amplifies' or 'catches' the heat energy or that the greenhouse gases act like a blanket surrounding Earth.

Question 9a.

Marks	0	1	2	Average
%	8	18	74	1.7

Most students were able to write a suitable hypothesis relevant to the experiment. Most were able to correctly write statements such as:

- Beaker A, containing carbon dioxide, will warm more compared to Beaker B, containing the air mixture

    or

- As the concentration of CO_2 increases, the temperature increase will be higher.

Question 9b.

Marks	0	1	2	Average
%	15	39	46	1.3

Students were usually able to identify that the purpose of Beaker B was to act as a 'control' in this experiment. Some students were unable to explain the purpose of a control or confused the concept with a 'controlled experiment'. Higher scoring responses made it clear that this enables the experiment to determine that the heat rise in Beaker A is due to the presence of higher concentrations of carbon dioxide compared to normal air, rather than any other variables.

Question 9c.

Marks	0	1	2	3	Average
%	15	20	26	39	1.9

The standard of response to this question varied considerably based on a clear understanding of each term. Not all students were correctly able to identify each of the three variables in this experiment. The key independent variable was the amount or concentration of CO_2 (given that air contains some CO_2) in the beaker. The dependent variable was temperature. Various controlled variables were correctly identified by students, such as the intensity of light, size of the beakers or the distance of the light source from the beaker.

Question 9d.

Marks	0	1	2	3	4	5	Average
%	11	4	8	18	47	13	3.2

The standard of graphing was quite high in general, with most students able to accurately plot the figures for both beakers from the data table and join them with a curved line. These were distinguished in the key, and both axes were labelled with time along the bottom and temperature up the side. Not all students included the units of time (minutes) and/or temperature (degrees Celsius) and the title of the graph was poorly labelled, with students often forgetting to include both variables. An appropriate title for the graph is 'The change in gas temperatures in Beaker A and Beaker B over time'.

Question 9e.

Marks	0	1	2	Average
%	12	19	68	1.6

Based on the hypothesis students gave for their answer in Question 9a., most were able to state that the data did support the hypothesis that the CO_2-filled beaker warmed faster than the one containing air. This explanation was based on figures from the data, with many stating that Beaker A reached a temperature of 32 °C after 10 minutes, compared to Beaker B, which only rose to 29 °C.