2019 VCE Environmental Science examination report

General comments

The 2019 VCE Environmental Science examination addressed knowledge and skills from all areas of Units 3 and 4 of the study design. Students should understand that any area within these units could be the focus of examination questions and the number of questions in the short-answer section may vary. All of the key science skills are also examinable.

It is important that students read each question carefully and take note of what is specifically being asked for. Some students unsuccessfully tried to use ideas and answers developed for questions on previous exams to fit new questions without addressing the specifics of the question being asked.

It was evident in some answers that students had some confusion with some key environmental science understandings. These include a number of incorrect, inaccurate or overly simplistic ideas including:

- discussing ozone depletion in the stratosphere as the cause of the enhanced greenhouse effect
- discussing the greenhouse blanket surrounding Earth as the cause of global warming
- not understanding the distinction between sustainability and ecologically sustainable development
- lack of clarity about the types and specific pathways of radiation that enter the atmosphere. In particular, there was confusion about incoming infra-red radiation from the Sun and the reradiated infra-red radiation from the surface of Earth. Infra-red radiation that leads to the heating of the atmosphere does not simply 'bounce off' Earth's surface.
- oversimplification of the idea of intragenerational equity when relating it to intergenerational equity. Many students only gave a basic distinction between the two as providing resources for the current generation (intragenerational) and providing resources for future generations (intergenerational). It is important to understand that the intragenerational concept does consider the needs of the current generation but also the equity of resource use within generations and across populations. It is not limited to allowing a particular population to use what it wants without considering the needs of others.
- discussing the environmental impacts of constructing dams for storage of water for hydro-electricity generation and inaccurately describing these impacts on the 'marine' environment rather than the riverine or aquatic ecosystem
- lack of precision in use of key terms; for example, in discussing solar radiation, students should not merely write 'IR' or 'UV' initially in their responses because some students do not know the correct full terms, while others also incorrectly wrote 'inter-red' or 'unviolet' radiation.

If a question asks for one example students should focus on their single best answer rather than listing a variety of possible ideas. Some students listed multiple, and occasionally contradictory, points, which was not an acceptable way to structure such a response.

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Specific information

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

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

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	%A	% B	% C	% D	Comments
1	86	10	2	3	A small number of students had the misconception that natural gas is not a fossil fuel.
2	11	71	1	17	
3	2	16	9	73	Some students were confused by the stronger infra-red absorption per molecule of methane compared with carbon dioxide.
4	18	23	37	23	Many students showed a lack of the knowledge required to answer this question, although the study design specifies knowledge of the relative proportions of gases, including greenhouse gases, in Earth's atmosphere.
5	75	9	5	10	
6	21	60	10	9	Ecosystem diversity refers to the variety of different ecosystems in a region, not just species diversity or within a particular ecosystem.
7	93	5	2	1	
8	90	1	7	1	
9	1	39	46	14	The nutrient cycle supports plants; it does not regulate them.
10	5	79	3	12	
11	1	2	3	94	
12	3	4	91	2	
13	4	84	5	7	
14	11	5	8	76	Option 3 would leave the remnant vegetation intact, and hence conserve biodiversity.
15	7	6	69	17	Approval would be required under the *Environmental Protection and Biodiversity Conservation Act (1999)* as a Commonwealth marine reserve is involved. A and D involve listing threatened species, but do not give approval. CITES is not involved as no trade in endangered species is involved.

16	44	2	2	52	The proposal is an example of an ecologically sustainable development, as it is aiming to restore an ecosystem. The most common incorrect response was A, bioremediation. Bioremediation refers rather to a process – the use of biological agents (e.g. microorganisms) – to correct or restore some ecosystems, especially chemically polluted sites. Biological agents would not be used to deal with large items of rubbish.
17	68	1	12	19	The question asked for two major investigations that should be undertaken. Clearly regulatory frameworks and stakeholder consultation would be considered essential. C, alternative site uses, was a possible consideration but no pollution sources were mentioned. Biological controls (D) would not be relevant to the scenario given.
18	2	10	14	74	Parkland for use by local residents is for human use – an anthropocentric motivation.
19	6	12	67	15	D was incorrect as there is no indication in the question that the new technology involves greater risk. B was also incorrect because there was no reference to any process required for ecological integrity to be considered.
20	6	87	2	4	
21	9	15	18	59	The values obtained were all significantly lower than the real result; hence, low accuracy. These results are all very close, so precision is high.
22	8	13	71	9	Percentage efficiency = output x 100 / input = 10.0 x 100 / 11.5 = 87%.
23	4	3	85	7	
24	2	77	2	19	
25	11	17	9	63	A and B are not models. C may be part of a climate model, but would not have the time frame essential to a climate model.
26	1	3	2	94	
27	89	1	7	3	
28	5	13	2	80	
29	6	64	21	8	Increase = final – initial = 1780 – 1600 = 180 ppb % increase = change x 100 / initial value =180 x 100 / 1600 = approx. 11%.
30	4	38	33	25	The ‘bumpy’ line represents seasonal changes. Longer term, from 1985 to 2000, there was increase. From 2000 to 2005 there was stability; from 2010 to 2018, increase. A and D were true, but were not the best description.

Section B

Question 1a.

Marks	0	1	2	3	Average
%	2	3	19	77	**2.7**

Most students were able to use the data and formula provided to correctly calculate Simpson's Index (D) for site R of 0.846. A few students made small mathematical errors in completing the table, which resulted in an incorrect final calculation. Although rounding the final figure to two decimal points was not required, a few students chose to incorrectly round the final figure down to 0.84 rather than up to 0.85.

Question 1b.

Marks	0	1	2	Average
%	7	61	32	**1.3**

In general students were able to describe the data collection technique used during ecological fieldwork. In general terms quadrats are a number of small areas of habitat of a particular uniform size (e.g. one square metre) selected at random to record representative samples for assessing the local distribution of plants or animals within a community. The technique is useful because it is not possible to count every plant or organism over an entire study area, and by recording representative samples scientists are able to make various useful population calculations. Some students incorrectly suggested they are only used for plants (i.e. organisms that do not move) or that they are an unbiased collection technique, without any explanation (locations for quadrats over a site may be selected at random or systematically, but always without bias).

Question 1c.

Marks	0	1	2	3	Average
%	13	46	33	8	**1.4**

Site Q had a Simpson's Index of 0.891, and therefore had a slightly higher diversity than the other two sites. Site R (at 0.846) was only very slightly higher than site S (at 0.844) and so the species diversity is almost identical at the two sites – the index figures are not significantly different. The key difference between sites R and S was the absence of sheep's sorrel (an introduced weed species) at site S, which meant the ecological quality at site S was better than site R (which had the weed present). Many students did not make both the similarity and difference between sites R and S clear and incorrectly stated that site R was more diverse than site S.

Question 1d.

Marks	0	1	Average
%	48	52	**0.5**

The degree of change predicted by the climate modelling (both the significant temperature increase and lack of snow cover/melt water) would suggest that the short alpine herbfield plant community would be unable to adapt and could disappear from the region, with most of the plants becoming extinct. Most students were able to correctly make this connection clear, although many stated that the community would be 'reduced' or would 'decrease', which was not specific enough.

Question 1e.

Marks	0	1	2	Average
%	53	42	5	**0.6**

Interpretation of the 'degree of confidence in climate modelling' is an important concept in understanding climate change projections and their usefulness. Higher-scoring responses displayed an awareness of variations in climate modelling and how assessing confidence in a prediction should relate to how complete the computer modelling is in terms of relevant variables and processes that contribute to global climate conditions. If the model is accurate, climatic processes and conditions can be simulated by the computer to produce results that match the collected data. Evaluating the model against past and present data is an indicator of the degree of confidence in the climate model. Some students had difficulty in clearly explaining how the degree of confidence in climate modelling is interpreted.

Question 1f.

Marks	0	1	2	Average
%	12	25	63	**1.5**

Most students made clear in their answers that a gene bank involves the collection and labelling of a wide variety of plant specimens, including the genetic material (seeds) from within the community and keeping this material safe in storage.

Question 2a.

Marks	0	1	2	Average
%	9	57	34	**1.3**

Some students found it difficult to focus on both parts of the question. Some made clear that a change in conservation category would indicate the degree of risk has been rated higher and the likelihood of extinction as more immediate. Because of this change in how the potential risk to the survival of the species is now viewed, and because the level of threat has increased, greater conservation efforts to address possible threats would be required. Lower-scoring responses tried to define and explain the difference between the 'threatened' and 'critically endangered' conservation categories.

Question 2b.

Marks	0	1	2	Average
%	5	37	58	**1.5**

Most students provided a basic understanding of translocation. They were able to explain that in this scenario translocation refers to the capture of a number of individual barred galaxias from one stream location, and then transporting and releasing them into another location (usually where there is another population present.) This could be a useful strategy in this situation because it allows for a mixing of the currently isolated population's genetic material to support diversity and increased chance of survival. It could also potentially remove the population from the predation of and competition from the trout to allow the barred galaxias' population to grow in numbers.

Question 2c.

Marks	0	1	2	Average
%	20	28	51	**1.3**

A variety of negative impacts on genetic diversity could potentially occur as a result of the translocation process. Higher-scoring responses gave a clear description of genetic swamping by explaining how the genetic material from the introduced population (usually larger) may 'swamp' or overrun distinctive features in the original population, thereby decreasing genetic diversity. Some students were able to explain problems related to the introduction of genetic mutations or a genetic disease into the second population, which could weaken genetic material and decrease overall population numbers. A third answer many students gave was an explanation of the potential problems that could result from removing genetic variety from an already small population, such as inbreeding or an increased risk of that reduced population being wiped out by catastrophic events.

Question 2d.

Marks	0	1	2	3	Average
%	10	6	23	62	**2.4**

The question was answered well overall, with most students being able to explain the difference between the two value systems clearly. The scenario presented was an anthropocentric view because the argument is based on the provision of trout for human enjoyment (fishing activity) and food, above the negative impacts on the stream ecosystems. An anthropocentric value system can be described as a human-centred view of the world, with ecosystems and species valued for their benefit to us. An ecocentric value system focuses on the value of the ecosystem as a whole (both the living and non-living components), which is put above the value of individuals or a single species, including the human species. Lower-scoring responses described the value systems too simplistically (for example, ecocentric is about ecosystems and anthropocentric is about humans).

Question 3a.

Marks	0	1	2	3	4	5	Average
%	13	9	16	27	25	10	**2.7**

Students responded to this question in one of two acceptable ways. In explaining how the proposal to develop the chicken farm could be considered as focused on sustainable development, students used the three principles (or pillars) of ecological, social and economic sustainability. They were able to use the information provided to clearly explain how the proposal would meet these three areas. Other responses explained how the proposal could address the ecologically sustainable development principles of intergenerational equity, intragenerational equity, conservation of biodiversity and ecological integrity, efficiency of resource use and the user pays principle.

Higher-scoring responses using either approach were well organised and able to clearly justify why the proposal would be regarded as a sustainable development by discussing how the various resources would be used in a way that continues their availability for future generations. Lower-scoring responses simply listed sustainability principles and tried to define them rather than relating those principles to the examples given in the proposal to develop and improve the farm's infrastructure.

There was some lack of clear distinction between the two terms 'sustainable development' and 'ecologically sustainable development', although the study design includes this distinction as key knowledge (page 26).

Question 3b.

Marks	0	1	2	Average
%	26	46	28	**1.0**

In answering this question students needed to make their understanding of the term 'biosphere' clear. Most students were aware that 'bio' refers to living things but lower-scoring responses only made reference to 'where things live' rather than the more specific description of the region on earth where living things are found. Many students were able to describe such impacts on the biosphere as improved soil quality through organic material being turned into fertilisers and used within the environment. This in turn aids microorganisms in the soil and plant growth. Another impact described was water reuse. By taking less water from rivers and maintaining higher base flows for stream life, there are decreasing impacts of lowered water levels in rivers, which is better for aquatic organisms.

Question 4a.

Marks	0	1	2	3	4	Average
%	2	4	21	43	31	**3.0**

Students needed to state one advantage and one disadvantage of using the solar panel systems as well as using the geothermal hydronic heating systems. Basic advantages are that these energy sources are non-fossil, renewable and produce few greenhouse gases. The main disadvantage identified for solar panels was the intermittent nature of solar energy, and for geothermally heated water the potential negative impacts on the lake ecology by removing water was the main disadvantage. It is not acceptable to state 'cheap' without any qualification (because both solar and hydronic systems are expensive to set up).

Question 4b.

Marks	0	1	2	Average
%	25	64	11	**0.9**

Students had difficulty in giving a fully accurate answer to this question. Most made a clear point related to the impact on the costs for the household; that is, that once installed, the costs to operate and gain energy would be decreased. However, many incorrectly stated that the amount of energy being used by the household would be reduced. Installing solar panels and using water heated from the geothermal spring changes the source of the energy but it does not necessarily change the amount of energy being used by the household.

Question 4c.

Marks	0	1	2	Average
%	24	63	13	**0.9**

Higher-scoring responses focused on identifying what would potentially be the key impacts (more than one) on the resources of the city if the new development used all the renewable energy sources in place of using current sources of water, coal-generated electricity and natural gas. By using solar and geothermal sources there would be less reliance on the city's other water supply sources and non-renewable energy resources, thereby extending their lifespan. Other high-scoring responses discussed economic impacts on the city's resources, such as not having to construct extra infrastructure (e.g. powerlines, power stations, dams) for the housing development or the

negative impact for the population of the city who may have reduced access to the lake after the housing development is constructed.

Question 4d.

Marks	0	1	2	3	4	Average
%	16	12	23	28	20	**2.3**

Students took a variety of approaches to answering this question. Most demonstrated a basic understanding of the two concepts in terms of providing resources for current and future generations, but many failed to develop the idea of the equity of resource use within generations when discussing intragenerational equity. Higher-scoring responses explained that the energy supply systems provided for intergenerational equity because the different energy sources (solar and geothermal) decrease the reliance on fossil fuel production, leaving coal and gas sources available for future generations to consume.

In discussing how the development addressed intragenerational equity, students generally adopted one of two approaches. Some students correctly argued that the development was not intragenerational because it was not 'equitable': the development put the cost back on residents of the new development to use renewable, sustainable sources and did not share these costs with the rest of the city's residents, who would gain some benefit by not having an extra load on their energy and water resources. Other students less successfully argued that it was intragenerationally equitable because energy sources were being provided for everyone in the city; and some form of energy was being made available for the whole population, thereby meeting current needs for energy. These responses didn't consider the question of fairness throughout the whole population.

Question 5a.

Marks	0	1	2	3	Average
%	30	25	27	18	**1.4**

The focus of this question was on the environmental impacts of accessing brown coal and hydro-electricity to provide electricity for Melbourne. Suitable answers indicated basic impacts on the environment of accessing each energy source, such as ecosystem clearing for large open-cut coal mining or damming of river systems to create dams used to generate hydro-electricity. An element of comparison between each of these environmental impacts was needed for full marks but was not always provided by students; lower-scoring responses did not focus on accessing each of the energy sources (rather they discussed transporting or using the energy source).

Question 5bi.

Marks	0	1	2	3	Average
%	15	17	22	45	**2.0**

Most students knew the basic process of converting brown coal into electricity and the energy forms involved. Lower-scoring responses left out the first energy conversion from brown coal (potential chemical energy) into thermal (heat) energy when combustion occurs in the furnace of the power station.

Question 5bii.

Marks	0	1	2	Average
%	22	33	44	**1.2**

The question was answered well in general, with most students able to state the steps involved in using the water stored in a dam (gravitational potential energy) to flow through a turbine (kinetic energy), spinning the blades (mechanical energy) and turning the generator to create electrical energy.

Question 5c.

Marks	0	1	2	Average
%	38	46	17	**0.8**

Not all students were clear in their understanding of the concepts underlying this question. Higher-scoring responses conveyed correctly that the distance the electricity has to travel in high voltage transmission lines from the power station impacts the relative efficiency of distributing electrical energy. This is due to the energy being lost as heat and sound as it travels through the transmission lines. Therefore, because the electricity from the Latrobe Valley only travels 150 km compared to 600 km from the Snowy Mountains, much less energy is lost during distribution. Lower-scoring responses discussed energy generation (rather than distribution) or incorrectly described transporting the coal or water (through pipes) to Melbourne to generate energy. Overall, there seemed to be a lack of knowledge of how electricity is distributed.

Question 6a.

Marks	0	1	Average
%	23	77	**0.8**

This question required students to accurately read the data in the graph showing monthly average sunspots received on Earth since 1950. There is a peak around 1958 and a sixth peak around 2015. 57 years divided by 6 is an approximate time interval of 11 years.

Question 6b.

Marks	0	1	2	Average
%	45	37	18	**0.8**

Students needed to use the graph to comment scientifically on the claim that the global warming experienced since the 1950s is due to changes in the number of sunspots. Based on the data shown in the graph the claim is not correct. There were random variations in sunspot numbers on the 11-year cycle and therefore no clear pattern that could be linked to global warming. Many students found the question difficult to answer, did not focus on what the question required (commenting on Isabella's claim using the sunspot graph), and incorrectly discussed other factors contributing to global warming since 1950.

Question 7

Marks	0	1	2	3	4	5	6	Average
%	18	13	16	16	13	10	13	**2.8**

The general level of understanding of the three cyclical variations as identified by Milankovitch was reasonable. Some students were able to fully describe and sketch each variation clearly and with

some correct detail, even including the length of each cycle or the change in axial tilt in degrees. The standard of students' diagrams varied considerably, and while this is not a test of drawing, it was expected that students would be able to convey the basic concepts of each cycle in a simple diagram. Lower-scoring responses confused the terms 'eccentricity' and 'precession' or made simple points such as that axial tilt is the 'tilt of the axis' or that precession is the 'Earth wobbling'.

Question 8a.

Marks	0	1	2	3	Average
%	19	16	28	37	**1.8**

There was a high degree of confusion in some responses and a lack of clarity in correctly identifying each of the three main types of radiation entering Earth's atmosphere from the Sun. Higher-scoring responses identified visible light, infra-red and ultraviolet radiation, and then accurately described their interactions as they pass through the atmosphere. Visible light largely passes through the atmosphere and reaches the surface of Earth, ultraviolet is mostly absorbed by the ozone layer in the upper atmosphere, and infra-red is largely absorbed as it moves through the atmosphere. Many lower-scoring responses confused the re-radiated infra-red radiation from the surface of Earth with the incoming infra-red radiation from the Sun.

Question 8b.

Marks	0	1	2	3	Average
%	23	22	33	23	**1.6**

The incorrect understanding of infra-red radiation mentioned in the previous question also affected responses to this question. Good answers correctly stated that visible light reaches Earth's surface, is mainly absorbed and then is reradiated or re-emitted into the atmosphere as infra-red radiation. For full marks, higher-scoring responses also included the reflection of visible light at Earth's surface due to the albedo effect.

Question 8c.

Marks	0	1	2	Average
%	28	39	33	**1.1**

Having correctly stated that infra-red is re-emitted, higher-scoring responses then identified that this radiation is absorbed by greenhouse gases in the lower atmosphere, heating them and causing the atmosphere to warm.

Question 8d.

Marks	0	1	2	3	4	Average
%	13	18	32	23	14	**2.1**

Satisfactory answers were able to describe the main differences (in causes and effects) between the natural and enhanced greenhouse effects. The natural greenhouse effect is due to naturally caused levels of greenhouse gases (mainly water vapour) in the atmosphere, keeping the temperature of Earth habitable. The enhanced greenhouse effect is due to various human activities (such as burning fossil fuels and deforestation) adding extra greenhouse gases (especially carbon dioxide) to the atmosphere, causing an increase in global warming and contributing to various changes (e.g. climate change, sea level rise, impacts on species and ecosystems). One mark was allocated to an explanation of how the natural greenhouse effect was different from the enhanced

greenhouse effect. A further two marks were allocated to the cause and effects of the enhanced greenhouse effect.

Question 9a.

Marks	0	1	Average
%	30	70	**0.7**

By using the figures from the graph and adding the annual average temperature for each of the years, most students were able to correctly calculate an average of 20 °C over the 10 years. Students should always include the correct units being used in their answers.

Question 9b.

Marks	0	1	2	Average
%	62	29	9	**0.5**

Based on the data presented, two key arguments that demonstrate that Leo's statement is incorrect were that the period of measurement is too short to draw any long-term conclusions (data for only 10 years), and that it is not valid to use changes at one location to draw conclusions about the behaviour of the global climate. Some students found it difficult to focus on Leo's statement and missed discussing why the measurements could not be used as evidence that climate change is not occurring.

Question 9c.

Marks	0	1	2	Average
%	22	48	30	**1.1**

Most students were aware that the main tool used by scientists to determine the likely future climate is climate modelling. Higher-scoring responses described in a little more detail that computer-generated mathematical climate models incorporate the physics associated with all the factors that determine climate. Scientists factor into these models various impacts, including increasing concentrations of greenhouse gases on Earth's energy balance, and evaluate past climate records (including relevant factors and processes) to project the range of likely future warming on Earth.

Question 9d.

Marks	0	1	2	Average
%	27	32	41	**1.2**

Most students were able to provide at least one factor that is likely to influence projections of future global warming, although not all were able to give two factors. Most understood that the rate of increase of greenhouse gas concentrations will determine the future extent of warming. In turn, that rate of increase will be driven by various changes such as future population changes, the rate of fossil fuel energy consumption, the extent to which renewable energy sources are used, the impact of any efforts to remove greenhouse gases from the air (e.g. through tree planting and geosequestration) and the rate at which ice sheets are melting.

Question 10a.

Marks	0	1	Average
%	45	55	**0.6**

Most students correctly identified the independent variable in the experiment as the different temperature of each digester system, either 25 ºC or 35 ºC.

Question 10b.

Marks	0	1	2	Average
%	26	24	51	**1.3**

Students were generally able to explain that a controlled variable is a factor that is kept the same throughout the experiment. In this case controlled variables included the amount and/or composition of the manure and water mixture, the pH of the mixture, the sealed digester system and the regular time period the gas volume is recorded. Students needed only to identify one of these controlled variables.

Question 10c.

Marks	0	1	2	Average
%	24	22	55	**1.3**

The experiment was designed to collect quantitative data because the results are objective, measured by and recorded with numbers. Therefore, the students recorded numeric data in the form of methane yields in L/g of pig manure. Alternatively, qualitative data is subjective, and is recorded by observations (descriptive and non-numerical rather than measurable in numbers). Most students were able to correctly identify that the data collected were quantitative but could not always distinguish clearly between the two terms.

Question 10d.

Marks	0	1	2	Average
%	17	55	29	**1.1**

Most students were able to use the data presented in the graph to explain that the volume of methane gas being produced between days 20 and 25 remained constant at around 0.33 L/g of pig manure, but not all students could explain why this might have occurred. Higher-scoring responses identified that the main reason was that all the organic material in the manure mixture had been consumed and converted by the microorganisms in the digester.

Question 10e.

Marks	0	1	2	Average
%	33	11	56	**1.2**

Some students demonstrated lack of understanding of the term ‘refuted’. The term is included in the study design and should be part of experimental discussions. High-scoring responses identified that the original hypothesis was correct and not refuted by the data. They explained that the results supported the hypothesis (that increasing the temperature of the mixture will allow for a greater volume of methane to be produced over time) was correct with the digester at 35 ºC producing higher methane yields than the digester at 25 ºC over the 25 days.

Question 10f.

Marks	0	1	2	Average
%	21	51	28	**1.1**

Students were generally able to list two environmental benefits of obtaining and using biogas as an energy source. These potential benefits included creating a renewable, non-fossil fuel resource and therefore having less reliance on fossil fuel resources such as natural gas. Other ideas included recycling animal waste, with less disposed of into the environment, which is a more efficient use of resources. Lower-scoring responses incorrectly stated that burning methane does not release any greenhouse gases.