2017 VCE Environmental Science examination report

General comments

The 2017 VCE Environmental Science examination was the first examination structured to address the new study design. The examination addressed knowledge and skills from all areas of the study design. Students are expected to be able to use basic mathematical skills and data forms such as graphs and understand and interpret scientific data.

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	% No Answer	Comments
1	11	29	8	52	0	Both options B and D were accepted for this question. High species diversity is most likely to be achieved by the most variation in conditions.
2	86	5	6	3	0	By definition, a mass extinction is likely to cause a high proportion of species dying out.
3	1	3	1	95	0	'Endemic' is defined as found only in this particular location.
4	2	74	3	21	0	Randomness removes any bias of the experimenters in selecting sites, leading to scientific validity.
5	27	12	57	3	1	Mark-recapture method – an estimate of the total population size can be obtained by dividing the number of marked individuals by the proportion of marked individuals in the second sample. Proportion of marked individuals in second sample = 12/38 = 0.316 Population = 60/0.316 = 190
6	1	8	86	4	0	The introduction of the waterlily is to purify the water by removing mercury.
7	3	5	19	72	0	Introduced waterlilies will compete with current native species.

Question	% A	% B	% C	% D	% No Answer	Comments
8	77	4	3	14	0	Since they are from the same genetic source, they would have similar traits.
9	1	77	6	16	0	'Extinct in the near future' is defined as endangered.
10	4	2	91	3	1	Since they are unsure, the precautionary principle should apply.
11	5	44	49	2	0	Ecological sustainability involves no long-term degradation. This is achieved by restoring the site after construction.
12	2	9	54	34	0	Ecological sustainability is a more restricted term – i.e. one aspect. Sustainability involves all three aspects.
13	3	13	78	5	0	
14	2	94	1	3	0	
15	6	24	5	65	0	'Peak oil' is defined as the year when extraction peaks. Option B was the most common incorrect answer. Peak oil refers to extraction, not consumption.
16	1	9	84	5	0	
17	77	10	8	5	0	
18	69	8	9	14	0	Efficiency could be improved by having less water in the furnace – that is, by using coal with lower initial moisture content.
19	16	2	80	3	0	
20	3	5	4	87	1	
21	1	8	8	83	0	
22	16	68	15	1	0	Computer-based simulations give future trends. Ice core and tree ring records give only data from the past; these trends may not continue.
23	0	71	2	27	0	This is due to the natural variability of weather. Changes in atmospheric composition will not cause random variation on a yearly basis.
24	84	7	5	4	0	
25	4	5	84	7	0	
26	2	9	80	9	0	
27	3	65	5	26	0	Uncertainty relates to the possible variation of each individual data line – hence the shaded area around each line.
28	36	10	2	51	0	Precision refers to variation between readings on a ratio or percentage basis. Total nitrogen varies by approximately 1 in 24 from the mean; pH varies by approximately 1 in 10. The total nitrogen is most precise.

Question	% A	% B	% C	% D	% No Answer	Comments
29	17	3	7	72	0	The same area is sampled, so location of sampling grid is the controlled variable.
30	50	34	8	8	0	Since the study is of variation over time, monitoring for a longer period would improve reliability. A common incorrect response was option A, having more groups taking measurements, which would reduce random variation but not reliability.

Section B

Question 1a.

Marks	0	1	2	3	Average
%	6	13	32	50	**2.3**

In order to calculate Simpson's Index of species diversity for Site B, students needed to use the information in the table provided and take the numbers given for each species to carry out each step of the given formula. A small number of students made basic mathematical errors, but most students were able to correctly calculate the final answer of 0.713. Some students missed the final subtraction step in the calculation and gave their answer as 0.287.

Question 1b.

Marks	0	1	2	Average
%	7	11	81	**1.8**

Students working on the statement 'a higher index value indicates greater species diversity' should have justified their answer based on the figure for Site A (0.795) and their calculated figure of 0.713 for Site B. Site A, with the higher index value, had the higher species diversity of these two sites.

Question 1c.

Marks	0	1	2	Average
%	8	69	23	**1.2**

Based on the Simpson's Index figures given for Site A (0.795) and Site C (0.336) and the correctly calculated figure of 0.713 for Site B, Site C had the lowest species diversity of the three sites. This would suggest that Site C has lower species richness (fewer different species), possibly with uneven numbers (relative abundance) between species. Most students understood the basic point but not all were able to explain what the figure suggested about species diversity.

Question 1d.

Marks	0	1	2	Average
%	12	73	16	**1.1**

Listing a species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* has the benefits of providing the vulnerable species with legislative or legal protection under a national framework and would result in a specific conservation strategy or recovery plan being prepared. Most students understood that the implementation of a conservation plan would

help protect the vulnerable bat species. Lower-scoring responses were not clear on the fact that this is Australian Government legislation and incorrectly discussed that the bat could be protected anywhere in the British Commonwealth.

Question 1e.

Marks	0	1	2	Average
%	50	36	14	**0.7**

Information in the stem of the question was used by some students to correctly explain two main bioethical guidelines observed by the scientists when trapping the microbats. Bioethical guidelines should focus on minimising any disruption, damage or disturbance to the species and ecosystem being studied. Checking the traps at least once overnight and at dawn reduced the stress on any animals caught, because they could be released quickly. Not all students understood the point about not using the harp traps during breeding and birthing season (over late spring and early summer) in order to protect pregnant females and young pups.

Question 1f.

Marks	0	1	2	Average
%	18	42	40	**1.2**

Most students understood that setting the traps a short distance from the main road, on a flat piece of land that was easy to access, would produce experimental results that were biased. Because the traps were not placed at random locations throughout the woodland, the results would be compromised and therefore less scientifically valid.

Question 2a.

Marks	0	1	2	Average
%	8	29	63	**1.6**

Students were generally able to discuss the problem that the extinction of the bat would result in fewer coastal brown ants being consumed, which would likely lead to an increase in the brown ant population. If the ants increased dramatically in number, this would lead to more competition within the habitat of the fritillary butterfly and could lead to the already endangered butterfly facing an increased risk.

Question 2b.

Marks	0	1	2	3	4	Average
%	2	6	28	37	26	**2.8**

In general, students were able to describe a clear advantage and disadvantage for each of the two management strategies. Ideas relating to captive breeding and reintroduction included that numbers may increase when animals are bred in captivity due to care and protection (advantage) and that captive-bred animals may struggle to survive when released back into the wild (disadvantage). A major advantage of translocating a small number of bats to a different area included expanding the range of the bats to an area that may have suitable roosting sites. Disadvantages of the translocation strategy included problems with the bats' ability to survive in a new habitat and the negative impact that the introduction of bats into a new area may have on other species.

Question 2c.

Marks	0	1	2	3	Average
%	20	9	30	41	1.9

Not all students understood clearly what the terms ‘anthropocentric’ and ‘ecocentric’ referred to. Higher-scoring responses explained the difference between the two values and linked this to the idea that the bat population was being protected for anthropocentric reasons, to provide tourists with an opportunity to view the species in the wild.

Question 3a.

Marks	0	1	2	3	4	5	6	Average
%	4	4	14	28	27	18	6	3.5

This question required a well-structured response, focused on justifying which of the two options for developing a port facility was the more ecologically sustainable. Students with higher-scoring responses specified one of the options and explained why this plan for a new port was more sustainable than the other, clearly using the information provided. Within this discussion, they generally used the three sustainability principles correctly and made clear their understanding of the terms. Not all students made clear that the idea of intragenerational equity is concerned with equity between people of the same generation with a consideration on evenly sharing resources.

Question 3b.

Marks	0	1	2	Average
%	45	32	22	0.8

Many students were able to explain that the user pays principle is a pricing approach based on the idea that the most efficient allocation of resources occurs when consumers pay the full cost of the goods or services they consume. Therefore, the users of the port – such as shipping companies and exporters/importers – should pay for any costs associated with any redevelopment plans for a new port, because this will produce the most efficient economic outcome. Some lower-scoring responses confused the user pays principle with the polluter pays principle, and tried to present an argument that the principle was about paying for any environmental damage caused by the port development.

Question 3c.

Marks	0	1	2	Average
%	23	62	15	1

This question asked students to describe one role each of the stakeholder groups could play in the decision-making process regarding the future development of a port. Not all students were able to make clear the role in decision-making of each group. Higher-scoring responses explained that government agencies have important responsibilities regarding implementing government policy and making sure regulatory frameworks and guidelines are met by any of the plans, as well as providing advice and recommendations to the government (the agencies do not make the final decision on a proposal). Environmental interest groups have a role in protecting key aspects of their local environment and making sure that their views are known during the consultation stage.

Question 3d.

Marks	0	1	2	3	Average
%	18	38	38	6	1.4

Any plans for port development should undergo a risk assessment with a focus on identifying the possible risks and likelihood of a fire occurring in the future. Having identified the risks, a plan to limit, manage and deal with any future fires should be developed. The possible effects on both the port site and nearby parts of the city (especially the residents) should be addressed. Not all students were able to outline these key elements of risk management planning.

Question 4a.

Marks	0	1	2	Average
%	39	19	42	1.1

The focus of the question was processes used in the rehabilitation of a mine site. Students needed to state a mechanical process (such as removing all power station buildings and associated infrastructure) and a chemical process (such as treating contaminated soils or polluted water at the site). A chemical process commonly stated by students was to return the pH of the soil to its original state; many students found it more difficult to state a mechanical process.

Question 4b.

Marks	0	1	2	Average
%	13	29	57	1.5

Although students presented arguments for both options, higher-scoring responses focused on the idea that replanting native eucalyptus trees rather than an introduced species like radiata pine trees would be better for the biosphere. Native species would tend to support a greater diversity of other plant and animal species. Students could have argued for replanting radiata pine trees, but in that case they needed to clearly explain that the area around the mine site is already pine forest and that replanting this species would support organisms already in the region by increasing the available habitat.

Question 4c.

Marks	0	1	2	3	Average
%	71	15	12	2	0.5

Students seemed to have a limited understanding of the concept of global warming potential. Very few understood that the combustion of natural gas produces carbon dioxide (and water vapour). Many students incorrectly argued that the higher global warming potential of methane was a valid argument for not converting from coal to natural gas. Most students knew that burning coal produces carbon dioxide but incorrectly stated that a power station using natural gas would be a greater problem for global warming because it releases methane with a higher global warming potential. Some methane might leak during processing and transport but this would be fairly insignificant compared to the amount of carbon dioxide released when a fossil fuel is combusted.

Question 5a.

Marks	0	1	2	Average
%	10	67	23	**1.2**

Students were asked to describe what is predicted to happen to coal production from 2012 to 2200 using data from the graph. Coal production was around 28 gigabarrels oil equivalent (Gboe) in 2012 and was predicted to rise to around 33 Gboe between 2020 and 2075 and then steadily fall to around 3 Gboe by 2200. Higher-scoring responses provided figures, units and dates in their overall description of the predicted pattern.

Question 5b.

Marks	0	1	2	Average
%	8	37	55	**1.5**

A variety of factors was suggested to explain why the predicted production rates of fossil fuel might change in the future. Two factors were required. Points given included improvements to technology that could make fossil fuel use more efficient; totally new energy technologies replacing current methods; the discovery of more reserves of oil, coal or natural gas; supplementing fossil fuel resources with renewable energy forms; and significant changes in total global population.

Question 5c.

Marks	0	1	2	Average
%	12	60	28	**1.2**

Responses to this question varied and not all students were clear on the purpose of modelling scientific data. Modelling allows scientists to evaluate current information and understand patterns of use in order to make predictions. These predictions help society and governments to consider our rates of usage and known energy reserves, and help them plan for or make decisions regarding future energy needs and provision of this energy. Some students also linked modelling of fossil fuel production to the production of greenhouse gas emissions and the impact this may have on global warming in the future.

Question 5d.

Marks	0	1	2	Average
%	12	63	26	**1.2**

Most students understood the concept of sustainability but some were able to clearly link the idea to the information in the graph regarding fossil fuel resources. The data in the graph suggested that the world's supply of the three fossil fuel resources will be virtually depleted by 2200 – they will not be available for future generations, which is a key component of sustainability. If these predictions are correct, then our use of these non-renewable resources is unsustainable.

Question 5e.

Marks	0	1	2	Average
%	11	36	54	**1.4**

Most students were able to clearly describe one impact of the decreased availability of fossil fuels. Impacts on society that were discussed included: a move from fossil fuel resources to other forms of energy – especially renewable sources such as wind, geothermal and solar, and nuclear energy

sources – and changes to society, with types of industries (and employment) moving from mining of fossil fuels and thermal power stations to technologies based on the construction and maintenance of wind turbines or solar cells. The main environmental impact that was described was a gradual decrease in the combustion of fossil fuels after the peak in 2030 and therefore a decrease in the production of carbon dioxide and decreased emissions of this greenhouse gas, with resulting consequences for global warming.

Question 6a.

Marks	0	1	2	Average
%	10	47	43	**1.3**

Students gave various disadvantages of using diesel as an energy source in the Antarctic. These included the need to transport diesel fuel for long distances to Antarctica, which is costly; the fact that diesel fuel can freeze at very low temperatures; the potential environmental damage of any diesel leaks or spills; noise disturbance from the generator; and carbon dioxide and other harmful emissions being released into the atmosphere from the combustion of diesel.

Question 6b.

Marks	0	1	2	3	Average
%	43	24	21	11	**1**

Student understanding of nuclear energy varied in the responses provided. While an in-depth knowledge of the nuclear fuel cycle was not required, students were expected to be familiar with how nuclear energy is created and to be able to describe the basic steps in generating electricity: the nuclear fuel (potential energy **not** chemical energy) undergoes fission (or fusion) to release heat energy to produce steam, and the steam then passes through a turbine causing rotation (kinetic or mechanical energy), which turns a generator to create an electrical current.

Question 6c.

Marks	0	1	2	Average
%	38	50	12	**0.8**

Overall, this question was not well answered. Few students were able to clearly explain that ‘efficiency of energy conversions’ refers to the ratio between input of energy from the energy source and the output of useful energy from each step in the conversion process. Many students wrote about the second law of energy, or discussed the idea that the greater the number of energy conversions, the more energy is lost, which was not the focus of the question.

Question 6d.

Marks	0	1	2	Average
%	15	57	29	**1.2**

Most students were aware of the intermittent and unpredictable nature of wind energy and included the need for a backup or storage system to supply energy when there was no wind available. Other answers included the idea that wind speeds over 250 km/h could damage turbines.

Question 7a.

Marks	0	1	2	3	Average
%	26	22	40	13	1.4

The standard of students' diagrams varied considerably. Most students were able to show the three types of incoming radiation (infrared, ultraviolet and visible light) from the sun and what happens to these types of radiation as they enter the atmosphere and reach the surface of the Earth. However, this was not the main part of the question. Students needed to focus on the natural greenhouse effect, which is mainly due to visible radiation being absorbed by the Earth's surface. This energy is re-emitted into the atmosphere as re-radiated infrared, which is then absorbed by the natural greenhouse gases (mainly water vapour and carbon dioxide) and these gases in turn trap heat. These steps were not always shown and labelled clearly in the student diagrams.

Question 7b.

Marks	0	1	2	Average
%	27	30	43	1.2

Most students were able to distinguish clearly between the impacts (not the causes) of the two different greenhouse effects. Key ideas were that the natural greenhouse effect maintains the planet at habitable temperatures, allowing current biomes to exist, while the enhanced greenhouse effect is causing global warming and, therefore, impacts such as climate change, including rising global temperatures, changes to extreme weather events and rising sea levels are likely.

Question 7c.

Marks	0	1	2	Average
%	40	16	44	1.1

Not all students were able to clearly identify and describe a method of carbon sequestration that could be used to reduce emissions from a coal-fired power station. Higher-scoring responses described how planting trees on a large scale around the power station removed carbon dioxide through photosynthesis; another suitable method was extracting the carbon dioxide from the station chimneys and burying it in stable rock layers, storing it in the long term (geosequestration).

Question 8a.

Marks	0	1	2	3	4	Average
%	13	10	20	24	33	2.6

Students were able to describe a variety of scientific methods used to estimate past global temperature and climates. The main methods explained were the use of ice cores (drilling down into older ice layers, removing and dating a core, and analysing air samples trapped in the tiny gas bubbles to understand atmospheric conditions in the past) and investigating paleobotany (studying and dating fossilised plant remains so that the data can be used to indicate climatic conditions in the past, including temperatures that would allow these species of plants to exist at that time). Other methods described by students included investigating tree ring widths and past sea level terraces.

Question 8b.

Marks	0	1	2	Average
%	81	2	17	**0.4**

The question required students to accurately read from the graph the atmospheric carbon dioxide concentrations in the year 1000 (around 280 ppm) and the year 2000 (approximately 370 ppm). This works out to be an approximately 32% increase in carbon dioxide levels. Most students did not know how to carry out this calculation.

Question 8c.

Marks	0	1	2	Average
%	21	56	23	**1**

Students needed to give two reasons to explain the increase in carbon dioxide concentrations. Most students were able to link the increase to the dramatic rise in fossil fuel combustion for energy production. The second major reason was the large-scale clearing of forests, which has reduced carbon sinks. Fewer students included this second reason.

Question 8d.

Marks	0	1	2	Average
%	10	11	79	**1.7**

Most students understood that a major impact of global warming was the melting of ice caps and ice sheets. As these ice forms melt, more water is added to the oceans and this raises sea levels. Some students were also able to explain that global warming raises ocean temperatures and that, as sea water heats up, its volume increases, which also contributes to rising sea levels.

Question 9a.

Marks	0	1	Average
%	34	66	**0.7**

The independent variable in this experiment was the angle of the solar panel to the sunlight. Most students were aware of the difference between independent and dependent variables when conducting experiments and gave the correct information.

Question 9b.

Marks	0	1	2	3	Average
%	30	17	28	25	**1.5**

Students were usually able to explain that the data being collected was quantitative rather than qualitative. They were collecting data by measuring the power in watts (therefore using measurable figures or numbers) rather than collecting qualitative data, which cannot be measured and expressed as a number. Not all students were able to make the meaning of qualitative clear in their answer.

Question 9ci.

Marks	0	1	Average
%	82	18	**0.2**

The line drawn on the graph should have been slightly curved to fit the numbers rather than a straight line. Few students were able to draw the correct line of best fit.

Question 9cii.

Marks	0	1	Average
%	16	84	**0.9**

Using the line produced on the graph, students were usually able to estimate that the power produced by the 45° panel was approximately 0.65 watts.

Question 9d.

Marks	0	1	2	Average
%	61	16	23	**0.6**

Many students overlooked the original hypothesis when answering this question. They usually understood that as the angle of the panel reduced, the amount of power generated declined – but it did not reach zero at zero degrees (which was the original hypothesis) and they did not comment on this point. They should have concluded that the students conducting the experiment were incorrect in their hypothesis.

Question 9e.

Marks	0	1	2	Average
%	30	26	44	**1.2**

Scientific reliability refers to how consistent the results are, and this reliability is usually gained by repeating the experiment multiple times. Therefore, the students should conduct their data collection a number of times, ensure readings are done at the same time, and average the results. To increase reliability they could also ensure that they checked that all panels were correctly operating and that the measurement tools were accurate.

Question 9f.

Marks	0	1	2	Average
%	27	28	45	**1.2**

Students correctly described a variety of health and safety guidelines. For example, care is needed when working outdoors and exposure to sunlight should be considered; therefore, drinking plenty of water and wearing sun protection, such as wide-brimmed hats, sunglasses and sunscreen, is required. Another issue related to the lifting and carrying of heavy equipment such as solar panels – procedures for lifting safely and using trolleys to transport equipment are an important aspect of following safety guidelines. Some students discussed the need for correct insulation of electrical circuits, to protect from electrocution issues. Lower-scoring responses discussed the need for lab coats, protective goggles and rubber gloves, as though it was thought the students were conducting a science experiment in a classroom.