

## Environmental Science and Society

Course Code: ESS315114

### General Comments

The written examination was generally well received by candidates and teachers.

In most cases, candidates provided very good answers. Where candidates performed poorly it was mostly due to inadequate detail in their responses. There were an unusually high number of nil attempts for some questions.

Candidates are advised to carefully read the questions, seek out exactly what is being asked of them and make connections to the course content they have covered during the year. This should provide scope for all candidates to attempt all questions.

Candidates are again reminded that the Information Sheet be used as a reference to assist them in constructing their responses. Responses that are written word-for-word from the sheet reveal little understanding of the required knowledge, and often yield little if any credit. Candidates should use the information and apply it to the question.

### Written Examination

The following section specifically comments on candidates' performance. Marking examiners have offered suggested answers to each question, followed by specific comment on aspects such as how the question was assessed, where candidates gained or lost marks, where they had difficulty in interpreting the question, or where candidates failed to comprehend what was required to successfully answer the question. The suggested answers are by no means prescriptive. Candidates providing different but valid answers were rewarded accordingly as noted by the examiners.

### Part 1 – Criterion 2

#### Question 1

- (a) Seed germination.
- (b) Two independent variables cannot be tested in the one experiment. The presence of smoke and different temperatures were the independent variables. Either one of these can affect germination, so each needs to be tested separately to determine which one influences the dependent variable.
- (c) All variables must be kept constant to ensure a fair test. The change in the dependent variable (seed germination) has to be shown to be directly attributed to the independent variable and not any other factor.
- (d) Seeds below the ground are respiring and so need oxygen to initiate germination. It is not until they produce leaves above the ground that they photosynthesise and use carbon dioxide. If CO<sub>2</sub> levels are increased, levels of O<sub>2</sub> are lowered and so the seed's ability to respire has been reduced. Seeds will not germinate under such conditions.

#### Comments

- (a) *Most candidates answered this part well, although some candidates said just "germination" or "seeds" and were only awarded ½ mark.*

- (b) Candidates needed to mention that two independent variables cannot be tested in the one experiment (1 mark) and that they need to be tested separately to determine which causes the change in the dependent variable (1 mark). Many candidates only mentioned one of these aspects and were awarded 1 mark only.
- (c) A common answer was that the variables needed to be fixed (already stated – no marks) or that fixing them would interfere with the data less, and were awarded 1 mark only. Many candidates did **not** state that each of these variables could be an independent variable which could influence seed germination (dependent variable), hence the need to ensure they are fixed.
- (d) This part was answered poorly or not at all. Most candidates did not understand that seeds do not photosynthesise and therefore do not need CO<sub>2</sub>. Many candidates mentioned the increased CO<sub>2</sub> levels increased temperatures, resulting in less germination or the seeds not being adapted to the increased CO<sub>2</sub> levels and were awarded no marks.

## Question 2

- (a) There are many possible hypotheses for this question. Acceptable answers include:  
 “Decreasing the pH of sea water leads to an increase in mortality of the symbiotic algae”  
 “The rate of coral bleaching increases as the pH level of the sea water decreases”  
 “The amount of symbiotic algae living on coral decreases as the pH of sea water decreases”
- (b) (i) Manipulating the Independent Variable: Samples of sea water can have the acidity increased by adding acid in small increments or by pumping CO<sub>2</sub> into the water.
- (ii) Measuring the Dependent Variable: Corals grown in tanks can have the percentage of bleaching measured/estimated.
- (ii) Establishing a Control: Separate tanks set up with corals as above but with the pH of the water at the current ocean pH.
- (c) Other factors critical to **all experiments**: all variables kept constant; an adequate sample size to give a good representation; ensure the experiment can accurately be repeated; all ethical considerations be taken into account; and measurable results. These are all important in this case as many tanks should be set up, the experiment needs to be able to be repeated and results compared after a set time frame, as this case deals with living organisms, the issue of stressing the corals will need to be addressed and the results should be able to be measured as a percentage of bleaching or weight.

## Comments

- (a) Hypotheses were generally stated poorly. Candidates needed to include one clear independent variable (1 mark), a clear dependent variable (1 mark), show cause and effect (1 mark) and be succinct and testable in the laboratory. Most candidates' hypotheses were not worded to be testable in a laboratory, the independent and dependent variables were not clear, or were too wordy and complicated with more than one of each variable or more than one sentence.
- (b) These parts were answered reasonably well depending on what the candidates' hypothesis was. Most candidates could identify which dependent was which and explain how to 'manipulate/change' or 'measure' each. However, the control was not as clearly outlined, often just stating “keep all variables constant” which was too vague.
- (c) This part was answered well with most candidates being able to name a large sample size, ethical considerations or ensuring all variables are kept constant being critical to all experiments. However, some candidates listed a 'method' or 'a discussion' as being necessary which yielded no marks. In several cases, no connection to the experiment in question was made.

### Question 3

- (a) Baseline data.
- (b) The diagram could include scales showing height and length, identify specific species and density of species or include the date and time.
- (c) Describe two of the following methods:
- Use quadrats to sample specific areas of a specific size, detailing species types, abundance, density and distribution within the square. These quadrats can be randomly chosen or be placed along a transect line.
  - Transects can be set up along sections of the sample area from the high water mark to the car park. Along this transect, all species are recorded with height and distribution. Sampling along the transect can be done as one continuous sample or at defined points.
  - Aerial or on ground photographs could be taken with known reference points and these used to make comparisons in the future.

#### Comments

- (a) *This question was answered well with most candidates saying baseline data. Some candidates called it "continuous data or monitoring" (no mark) or just said it was a "survey" (1/2 mark).*
- (b) *Candidates answered this part well, stating that the diagram needed scales or measurements or the species of plants identified. Some suggested adding abiotic factors like identifying soil types which was given full credit. Some candidates stated this study would be useful in the future but did not go on to say how the diagram could be improved and given no credit.*
- (c) *This section was generally well answered with candidates outlining the procedure for sampling using quadrats and belt transects. Some candidates suggested graphing the area or surveying the fauna (no marks), or photographing the area (1 mark).*

### Question 4

- (a) (i) Site 1 can be used as a control sample to compare the other 5 samples to. This area is free from the impacts of industry and urbanisation so should give good baseline data.
- (ii) Conductivity is a measure of water's ability to conduct electricity through dissolved ions in the water. This gives an indication of the quality of the water- the higher the amount of salts such as chlorides, sulphates, carbonates and heavy metal salts, the poorer the quality of the water. Increased conductivity can indicate runoff into the stream from industrial discharges, land clearing, soil erosion and agriculture and urbanisation in the form of sewage and effluent discharges. This can negatively impact plant and animal life living in the water.
- (b) Pollution in the form of raw sewage entering the stream or faecal matter from animals can contribute to levels of *E.coli* bacteria in the water. Storm water runoff can also increase levels. The sources of *E.coli* should be identified. High levels of *E.coli* can indicate the presence of waterborne pathogens which can be dangerous to humans.
- (c) Suggest one of the following:
- More sampling points could have been included along the stream to give a thorough investigation.
  - More than one sample needs to have been taken at each point to ensure consistency and reliability of results.
  - Other abiotic factors should have been recorded at the time of sampling, such as temperature, wind speed, rainfall or recent past rainfall.
  - Samples taken at different times or over a longer period of time to reflect daily or seasonal changes.

## Comments

- (a) (i) Most candidates answered this part well and were able to answer that the sample at Site 1 could be used as a control (1 mark) and this baseline data be used to compare with the other sites further downstream (1 mark).
- (ii) This part was not answered well. Many candidates did not seem to understand what conductivity was, even though it was outlined in the information booklet. For 2 marks candidates needed to briefly state what conductivity measures (1 mark) and how high conductivity levels can indicate pollution and poor water quality as outlined above (1 mark). Many candidates did not gain the full 2 marks as they were not able to outline what could contribute to high levels of conductivity or how this impacted water quality other than to say it made the water "more salty".
- (b) Many different answers were suggested here, with the majority of them not being completely accurate. Some examples were turbidity, algae, pollution, or temperature which were awarded ½ mark only. Some better candidates suggested dissolved oxygen levels, amount of Biological Oxygen Demand, the presence of indicator species or the presence of faecal matter or sewage (1 mark). It seemed few candidates actually understood what was meant by the word "factor". Many left this part blank.
- (c) This part was answered quite well.

## Question 5

- (a) Aerial photography, satellite imagery, or LiDAR (Light Detection and Radar) are methods of collecting data on a large scale using remote sensing. Images can be photographed/downloaded onto a computer showing areas of land affected by salinity. These would show up as areas not covered with crops.
- (b) This data could be checked or calibrated against field measurements taken by hand using salinity meters or by using a GPS to map the extent of salinity and comparing it to the data collected remotely. Other surveying techniques like taking soil samples back to the lab to measure salinity levels (conductivity) or total soluble salts can also be completed for comparisons.
- (c) Abiotic factors that could be measured remotely could include the pH of the soil, the moisture content of the soil or the water table level, the temperature (air), wind speed, humidity, soil structure and type and levels of nitrates and phosphates in the soil.

## Comments

Many candidates left all three parts of this question blank and it was apparent candidates found this question difficult.

- (a) This part was answered poorly, with many responses simply stating "survey the paddocks" or "place probes/meters/sensors into the soil". For the 2 marks, candidates needed to name a method to gather data remotely (1 mark) and then go on to describe how the areas of salinity would be identified and recorded, usually via a computer (1 mark).
- (b) This part was also not answered well. Most candidates who may have answered part a) correctly, lost marks here for saying to use computers to upload the data. This was awarded no marks as computers would have been a necessary part of recording the data remotely anyway. Some candidates did mention doing field surveys or collecting soil samples and comparing these results with data collected remotely (1 mark awarded) but needed more detail in their explanation.
- (c) Most candidates were able to name one other abiotic factor that could also be measured remotely, such as one of those listed above. A few candidates said the amount of vegetation (no marks) or did not relate the abiotic factor to the farm in question.

## Part 2 – Criterion 5

### Question 6

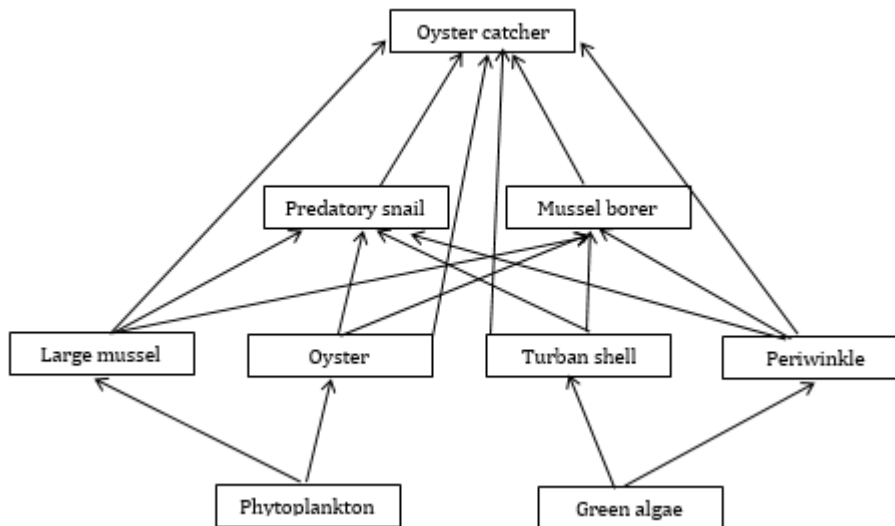
Species	Relationship
Eucalypt tree and nesting Swift Parrot	Commensalism
Sugar Glider and adult Swift Parrots	Competition
Sugar Glider consuming SP eggs or chicks	Predation
Various species of part using the nest hollows	Competition or commensalism

Comments

This question was generally answered well.

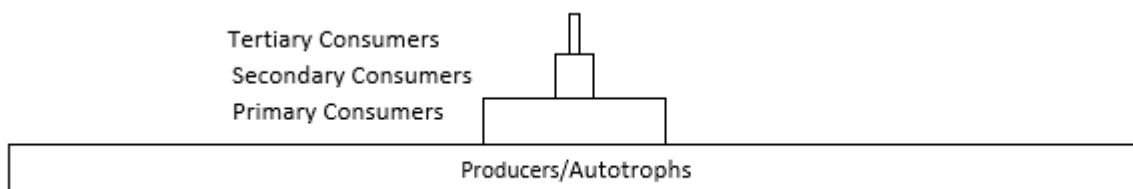
### Question 7

(a) An example of a possible food web for this question is shown below.



(b) Producers gain all their energy from the sun (via photosynthesis) for growth (1). All organisms above them on the food web only can access 10% of the energy available therefore there will be less of all other organisms (1).

(c)



(d) 2<sup>nd</sup> trophic level / first order consumer

(e) Scavengers / detritivores

Comments

(a) Common mistakes – majority of candidates did not understand what filter feeder and grazing consumers were, placing the grazing consumers above the filter feeders which resulted in less marks being granted. Candidates did not have to show all feeding relationships to be awarded full marks as the question only asked for a possible food web.

- (b) Needed to mention why producers are more abundant than consumers (only one mark awarded if they only discuss the producers without referring to the other organisms). Many candidates gave vague answers about intertidal areas providing lots of niches for producers without acknowledging that they get their energy from the sun and that they then need to provide all organisms about them on the food web with energy.
- (c) Relatively well done. Student need to remember to label the pyramid and show a reduction in biomass between each trophic level equivalent to ~90%.
- (d) Well answered.
- (e) There was some confusion about niche and habitat. Many candidates described the habitat they would be found in rather than identifying their niche role.

### Question 8

- (a) All organisms are open systems – they exchange energy and matter with their environment (1); they require inputs of energy and substances e.g. food, sunlight ( $\frac{1}{2}$ ); they produce wastes that are released into their environment e.g. CO<sub>2</sub>, faeces ( $\frac{1}{2}$ ).
- (b) Earth is an almost closed or partially open system (1 mark awarded for either) as it exchanges energy with its surroundings in the form of radiation and heat ( $\frac{1}{2}$ ) but exchanges no (or very little) matter ( $\frac{1}{2}$ ).
- (c) Energy cannot be created or destroyed, it is only transferred/transformed (1); energy arrives on Earth as radiation from the Sun which is then transformed via photosynthesis ( $\frac{1}{2}$ ) into chemical energy which passes through food chains and is released as heat ( $\frac{1}{2}$ ).
- (d) Negative feedback ( $\frac{1}{2}$ ), as the process of nutrient recycling stabilises the system ( $\frac{1}{2}$ ). Nutrients are removed from soil by plants but when the plants die the nutrients are recycled back into the soil by decomposers, this serves to return the system back to normal (no increase or decrease in nutrients) (1)

### Comments

Multiple answers were accepted for many parts of the question.

- (a) Only (1) mark was awarded if candidates identified an organism as an open system and stated the definition from the information booklet. Candidates needed to explain/use examples to get the full marks, needed to refer to both the exchange of matter and energy.
- (b) Marks awarded whether the candidates said Earth is closed except for energy, or open but only to energy.
- (c) Many candidates just put the definition of the First Law of Thermodynamics from the information booklet without explaining how it applies to energy flowing through ecosystems.
- (d) Candidates fared poorly on this question demonstrating limited understanding of feedback. As such, marks were awarded for stating whether it was positive or negative ( $\frac{1}{2}$  mark for either) then the rest of the marks were awarded based on their explanation.

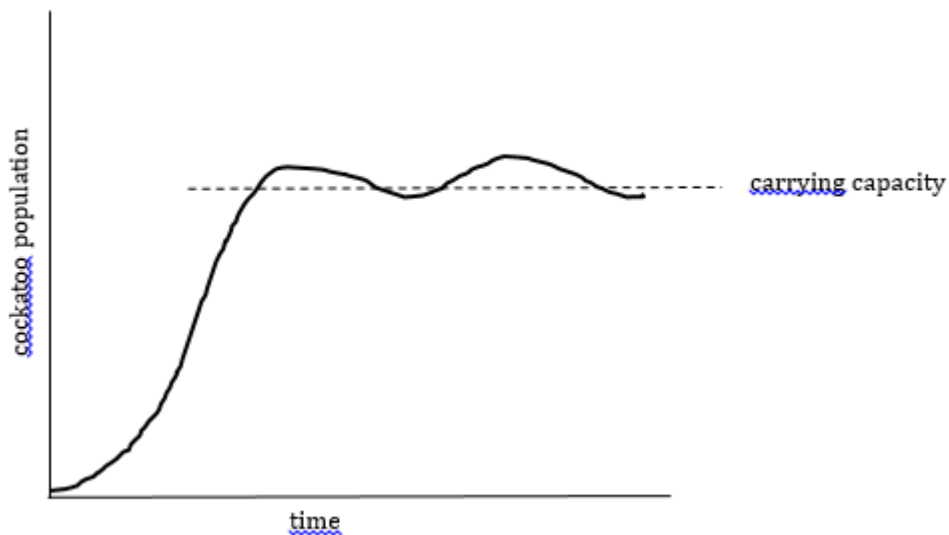
### Question 9

- (a) Abiotic factor - Increased temperature ( $\frac{1}{2}$ ) leading to an increase in their range or increasing the area that suited their zone of tolerance ( $\frac{1}{2}$ ); OR decrease in rainfall ( $\frac{1}{2}$ ) leading to an increase in tree deaths and therefore more tree hollows ( $\frac{1}{2}$ )

Biotic factor – more dead or dying trees leading to an increase in nest hollows

Biotic factor – increase in grassland (eg. farm paddocks) which is providing an increase in food for the birds

- (b) Marks for graph - 2 marks for curve (1 for showing early exponential growth, 1 for showing the later fluctuation around carrying capacity); 1 mark for labelling.



- (c) S-curve or logistic growth curve.
- (d) Birds of prey are top order consumers (1/2); they rely on food from lower down the food web (1/2) therefore their increase indicates an increase of all species below them which only occurs in a healthy ecosystem (1).

#### Comments

- (a) Many abiotic and biotic factors were accepted such as lack of predators, lack of competition (1/2 mark for stating factor, 1/2 mark for linking it to the increase in the range of cockatoos). Many candidates were only awarded half marks for this question as they stated abiotic/biotic factors without linking to the increase of cockatoo populations.
- (b) Most graphs done well, although quite a few candidates only did the population for the last 20 years without extending into the future, probably due to not reading the whole question.
- (c) Well done.
- (d) Some very vague answers given, particularly when candidates didn't identify when the birds of prey were top order consumers. Credit was given for discussing the role of top order consumers in keeping the ecosystem healthy by preying on weak/sick organisms from the lower trophic levels.

#### Question 10

- (a) Evolution or natural selection or speciation
- (b) Leaves became smaller in response to warmer climates (1) and therefore are smaller to reduce the amount water lost through the leaves (1).
- (c) Stating the abiotic factor (1 mark) and explaining the link to *Nothofagus* distribution  
 Example answer: *Nothofagus* is found in high altitude areas on the mainland of Australia and on the west coast of Tasmania. These are areas with higher than average rainfall, and *Nothofagus* requires high rainfall to survive.

#### Comments

- (a) No marks awarded for stating adaptation.
- (b) Many candidates stated that the leaves have evolved to suit changing environmental conditions and their responses required more specific detail, including the exact change and how this links to a decrease in leaf size.

(c) Candidates needed to refer to distribution in Tasmania and on mainland Australia for full marks.

### Question 11

- (a) A: photosynthesis. B: respiration
- (b) There is no link between decomposers and fossil fuels as when decomposers break down organic matter, the carbon is not available for fossil fuel formation (1). Fossil fuel formation requires organic material to be buried/compacted (fossilised) over long periods of time without decomposition (1). (1/2 mark awarded if candidates just stated that there is no relationship between decomposers and fossil fuels)
- (c) ½ mark for arrow, ½ mark for label. Many possible arrows e.g. scavengers/detritivores → CO<sub>2</sub> in air (respiration); plants → CO<sub>2</sub> in air (respiration); decomposers → CO<sub>2</sub> in air (respiration); fossil fuels → CO<sub>2</sub> in air (combustion)

#### Comments

Parts (a) and (c) were done very well. Part (b) was a challenge to many candidates; there appears to be a generally poor understanding of fossil fuel formation and how it fits into the carbon cycle. Also many candidates confused energy flow with the movement of carbon, which detracted from their answers. A lot of candidates stated that decomposition is aerobic and fossil fuel production is anaerobic – decomposition does not have to be aerobic and this also does not explain why there is no arrow between them.

## Part 3 – Criterion 6

### Question 12

- (a) (i) Lightning strikes are a natural cause and have been happening over many thousands of years.  
OR  
Periods of drought due to El Nino have been happening for many years that increase the amount of fuel available when lightning strikes.
- (ii) Increased global warming due to the combustion of fossil fuels, caused by human activity has led to a greater incidence of storms and lightning strikes or more dry fuel.
- (b) Rainforest plant species will be killed by bushfire whereas eucalypt species require fire for regeneration. Following a bushfire, eucalypts are one of the first species to grow. This is followed by the rainforest species growing in the shade of the eucalypts. When the eucalypt start to die after about 400 years the rainforest species dominate the forest and prevent eucalyptus seedlings from growing. This is therefore much longer than a human life time. Rainforest cannot regenerate in full sunlight.

#### Comments

- (a) The main problem was that candidates did not necessarily answer the question and note the **extent** to which fires are natural or human influenced which meant only a maximum of 3 out of 4 marks could be achieved.
- (b) Some candidates just copied straight from the information sheet without relating the information to the quote, others totally ignored the question and did not note time periods or that there was a change of plant communities before the rainforest was re-established. Other candidates did not link their answer to the quote.

### Question 13

- (a) (i) Diurnally. For one mark the following answers would be appropriate:
- As the tide ebbs and flows the water level in the estuary decreases and increases and the direction of the currents change.
  - The water temperature changes though out the day and night as the sunlight heats the surface of the estuary.



- The fresh water and salt water content change as the tides cause the ebb and flow with high tide increasing the salt water content.
- Productivity will increase during the day as there is more sunlight.

(ii) Seasonally. For one mark the following answers would be acceptable:

- Increased rainfall and inflow of fresh water will increase the volume of the river and the height of the river.
- Higher temperatures in summer will result in higher water temperatures which will reduce the dissolved oxygen.
- Higher temperatures will increase productivity in summer.
- Different species will be found living in the estuary in summer compared with winter.  
*There are many more acceptable answers.*

(iii) On an irregular time frame. For one mark the following answers would be acceptable

- Increased water levels during floods, the river may change its course.
- Lower water levels during drought.
- Floods may result in decreased salt levels.
- Storm surges- tsunamis can increase the salt levels or change the shape of the estuary.

(iv) As a result of human activity. One of the answers below was appropriate:

- Increase in flood frequency due to land clearance.
- Irregular flow due to discharge over hydroelectric power schemes.
- Reduced flow due to diversion for irrigation or dams.
- Increased silt levels due to land clearance and sedimentation in the estuary.
- Nutrient enrichment due to runoff of farm chemicals or sewage upstream.
- Dredging could increase turbidity.
- The amount of debris may spike after a flood or from landfill if close to the river.
- Sea level rise due to human enhanced global warming and inundation of the lower estuary.
- Increase in pH levels due to industrial activity upstream.

(b) Floods result in a decrease in salinity due to more freshwater and drought increases salinity concentration due to less freshwater. A good answer related the event to salinity. Acid rain was given and accepted since it may change the salinity, tsunamis and storm surges were also acceptable.

(c) Increased water temperatures in Tasmania due to climate change have put oysters outside of their zone of tolerance and may have stressed the oysters making them more susceptible to viruses such as POMs.  
OR

The East Australian current has brought warm water further south which is conducive for the POMs virus flourishing which is devastating the oysters.

#### Comments

*This was potentially a good question often with many plausible answers for each part. It allowed plenty of scope.*

*Unfortunately many candidates did not capitalise on this because they failed to follow the question and **describe** one change likely to occur in the estuary. Many thought a one word answer was sufficient; at the most they received half a mark for this.*

#### Question 14

(a) The term used to describe an environment where there are a large number of species is Biodiverse. Also allowed was diverse and species diverse.

(b) Biodiversity is reduced due to Long-spined Sea Urchin (LSSU) eating the kelp and producing a "barren" on the sea bed. Other species lose food supply, shelter from predators and habitat. This results in an unstable ecosystem. Less producers means less other organisms in the system at higher trophic levels.

- (c) There are several acceptable answers for this question, only one is needed. Examples include: few predators and competitors, unlimited food supply and other resources.
- (d) To preserve the biodiversity in different locations around the state and the biodiversity may be different in each area. Back up, insurance against disasters in one particular area. Species can migrate from one MPA to another.
- (e) Lack of genetic diversity since the population is derived from a limited number of individuals.
- (f) Acceptable suggestions included:  
Sea urchins sold for food on the Japanese market but sea stars are economically worthless. LSSU creates a barren and is easy to see and they are found inshore where divers could find them. Sea star more widespread due to spread by ballast water. Sea stars have been in our waters for longer and therefore more chance to breed. New technologies and experience allow for better finding of the sea stars.
- (g) Predator or biological control. Quite a few candidates wanted to introduce a chemical or toxin into the water – only if they mentioned that it would only target the sea urchin or sea star were they awarded marks.

#### Comments

- (a) *It was surprising how many candidates did not identify biodiverse as the answer*
- (b) *Candidates needed to state the effect on the environment to obtain two marks.*
- (c) *Quite a few candidates did not read the question carefully enough and only wrote about the advantages of Marine Protected Areas.*

#### Question 15

- (a) The sea water warms the cold European air above it. Quite a few candidates did not explain the label.
- (b) Europe will get colder and possibly enter another ice age since warm seas no longer reach Europe.
- (c) Ocean acidification.
- (d) More difficult for organisms to produce their shells as they cannot extract the calcium carbonate from the water. Shells are thinner therefore shellfish and crustaceans more prone to predation or accidents that damage their shell causing the organism to perish. They are more likely to die or be preyed on. Coral bleaching since the symbiotic algae will be expelled when the coral is under stress (acid water).

### Part 4 – Criterion 7

#### Question 16

Users of the rivulet had free, unregulated and unmanaged access to the water (1) and degraded the quality of the water resulting in it being unusable and businesses had to move upstream (1). Selfish overuse of the resource by some users (eg tannery, abattoir) without consideration of others' use (1) shows this is a Tragedy of the Commons to a large extent and well represented in the example of the Hobart Rivulet (1)

#### Comments

*All candidates attempted this question and half marks were awarded if an explanation was not clear or complete. An information 'dump' straight off the information sheet defining a tragedy of the commons was not awarded marks as it showed no understanding of the context of the question in the answer. Many candidates did not clearly outline the extent to which they thought this example may have been illustrating a tragedy of the commons, ie was it an example or not.*

Some candidates missed the focus of the question and responded in terms of a criterion 5 answer and discussed abiotic water quality issues from the run-off.

### Question 17

- (a) Food, water, transport, housing, wastes produced, energy consumption (any 4 for 2 marks, half a mark each).
- (b) They are approximate values and averages only, each individual may be different in their resource use (eg food packaging, food miles) (1). Some websites may ask many more specific or detailed questions than others and weight different aspects of the information differently in the final calculation (1).
- (c) The land area required to supply all resources of a person; a hectare of biologically productive space with an annual productivity equal to the world average (1).
- (d) Use public transport, car pool, walk or cycle rather than use fossil-based fuels in cars/buses (1) which releases CO<sub>2</sub>, contributing to carbon emissions (1).

Clear, detailed answers using the example of changing to vegetarian diet rather than eating meat and reducing food miles by sourcing local produce were also awarded full marks.

#### Comments

*This question was well-answered by most candidates.*

- (a) *Generally well answered.*
- (b) *Candidates were only required to list main factors, and this was fairly straightforward as the factors were on the information sheet.*
- (c) *This question was also fairly straightforward and attempted by all candidates.*
- (d) *This was fairly straightforward as the factors were on the information sheet. Many candidates wrote that we would need 10.5 earth's to supply her needs, rather than demonstrating they understanding of global hectare.*
- (e) *Candidates who did not make the link between the practices they used as an example (eg go vegan, use public transport and car pool) and how this would decrease their fossil fuel use/contribution to CO<sub>2</sub>/methane emissions and were not awarded full marks. Some answers were too general and could have been responding to reducing energy or resource consumption, not specifically carbon footprint as asked.*

### Question 18

- (a) Electric vehicles; cars are able to run on electricity from battery storage and if generated from renewables, this requires less petroleum products (1).  
Biofuels; these fuels can supplement or replace fuels similar to diesel and are renewable, as they are made from plants (1).  
Hybrid vehicles; these run on a combination of petroleum and electric battery systems, partially replacing the need for so much petroleum (1).  
(Clear, detailed answers describing hydrogen fuel cells or similar new technologies were also awarded full marks. Only two technologies needed to be described for 2 marks).
- (b) Biofuels are preferable to burning petroleum as they are renewable (½) and have no net carbon gain (½), unlike fossil fuels which contribute to CO<sub>2</sub> emission and increase greenhouse gas concentrations in the atmosphere (½). They are infinite, unlike finite petroleum (½).

Electric vehicles are preferable to burning petroleum as they have zero net CO<sub>2</sub> emissions if generated from a renewable source, such as hydro, solar or wind power (1). They are infinite, unlike finite petroleum (1).

## Comments

- (a) *This question was generally well-answered by candidates. However some candidates did not clearly describe the technology and just named it, or didn't describe clearly how the technology was able to replace petroleum.*
- (b) *This question was generally well-answered by candidates. However some candidates did not clearly describe why the new technology was preferable to burning petroleum and just made points about the technology. Many answers were too vague and mentioned 'green' or 'clean' technologies that were 'better for the environment' without specifying how they were preferable to using petroleum. Two alternative methods for allocating marks are demonstrated above for this section.*

## Question 19

- (a) Biomagnification (1). DDT was sprayed on the mosquitos, the poison was absorbed and as it is persistent and cannot be excreted, it is transferred up trophic levels to the top of the food chain (1). As biomass decreases at higher trophic levels, the DDT becomes more concentrated, killing geckos and cats (1).
- (b) Non-specific; DDT is a non-specific and affects a range of organisms in the food chain, not just the mosquitos (1).  
Persistent/non-biodegradable; DDT is persistent in the environment and not readily broken down through natural processes, so it will remain toxic for a long time (1)
- (c) A contaminant is a substance that is present in small quantities in a community, but not harmful (1). It is considered a pollutant when it becomes more widespread/concentrated and starts to cause harm to organisms exposed to it (1).
- (d) It is a natural plant product, so it will biodegrade and not accumulate in a food chain (1).

## Comments

*This question was generally well-answered by candidates, with all candidates attempting the question.*

- a) *Some responses here were too general, rather than outlining the biomagnification process in a food chain.*
- b) *Marks were awarded for stating DDT was non target specific, persistent in the environment, easily ingested, not easily excreted or similar responses. Some answers were supplied which were the effects of DDT, rather than properties of it.*
- c) *Most candidates answered this question well and were able to describe the difference between the two substances.*
- d) *Most candidates answered this question well; marks were also awarded for answers mentioning target specificity for insects rather than it being non-specific and that it could not bioaccumulate or biomagnify.*

## Question 20

Ecosystem services encompass provisioning services (eg. water and food), regulating services (eg. climate and pollination) and cultural services (aesthetic and cultural heritage) (1). Many of these services provide natural capital (eg. food, freshwater and forests) (1) which can then be converted into economic capital, such as ecotourism experiences, fuel wood and bottled water (1) as soon as they are bought, sold or have, or are perceived to have, an economic value (1).

## Comments

*This question was not well answered by candidates. A quarter of all candidates did not even attempt to answer this question, preferring to move onto a more accessible question. Many candidates did not successfully link the ecosystem services to natural and then economic capital, or provide relevant examples. The information sheet was helpful by guiding candidates in defining ecosystem services to begin with.*

## Question 21

- (a) Any of the following responses were acceptable:  
Less wild fisheries are available as a resource due to overfishing (1), there is an ever increasing consumer demand for high quality fish products which is being met by aquaculture (1), we have the technology and knowledge to successfully farm certain key species of table fish to meet consumer demand (1)
- (b) Ensure that wild fisheries are not overfished so that they can continue to supply humans with food into the future (1). Target species need to have numbers, ages and total catch managed and monitored to ensure overfishing does not occur (1). Managing wild fisheries is essential so the prey of target species can be sustained also (1).
- (c) Any of the following responses were acceptable:  
Setting total allowable catch (TAC) or annual quota (1), having open/closed seasons so they can breed, have MPA's (Marine Protected Areas) which act as no take zones and spawning/protected breeding grounds (1), have strict licensing conditions to prevent overfishing (or similar responses).
- (d) Waste food and faeces from the pens ( $\frac{1}{2}$ ) may add to eutrophication in surrounding waters ( $\frac{1}{2}$ ), stimulating significant algal growth ( $\frac{1}{2}$ ) which may then result in low D.O. levels as the algal mass dies and decomposes ( $\frac{1}{2}$ ).

### Comments

*This question was generally well-answered by most candidates. In part (b), candidates' answers digressed to talking about intergenerational equity and maintaining ecosystem diversity for broader ecological purposes, rather than linking their response back to why wild fisheries need to be managed for human food production. Many candidates in part (c) neglected to notice that the question was pertaining to wild fisheries, not aquaculture, and many candidates responded with 'hanging nets to deter predators', which was totally inappropriate for a wild fishery. In part (d), the responses that did not receive full marks were too vague or general, mentioning only 'waste', 'water pollution' and 'bad effects on the environment'.*

## Part 5 – Criterion 8

### Question 22

- (i) Inter-generational Equity – The forest resources and biodiversity should be preserved and not degraded for future generations to enjoy, and not have to clean-up waste or degradation.
- (ii) Intra-generational Equity – The forest resources should be available to all stakeholders (eg. bushwalkers and Aborigines) not just the logging industry.
- (iii) Interspecific (between species) Equity – Humans have an ethical or moral responsibility to protect and value all species not just the species that have economic value.
- (iv) Ecological Integrity – The forest should be managed so that it is able to continue to fully function and provide all Ecosystem services.

### Comments

*Generally this question was answered quite well and was a good starter question for the beginning of the booklet. Linking the answer to forests/forest resources was essential for full marks. Only a few candidates confused (i) and (ii) as these definitions are given in the information booklet.*

### Question 23

- (a) MEDCs have poverty and basic needs met so there is economic stability that gives time and money to preserve the environment. MEDCs have money to install new technology such as renewable energy or protect and manage reserves/national parks. LEDCs are more focused on feeding growing populations and generally have less economic stability. This often results in less sustainable activities such as poaching of 'bush

food' or other animal parts, e.g. rhinoceros horns. Threatened species and biodiversity in general become degraded so that 'sustainability is harder to achieve when there is less economic stability' is generally true.

- (b) Mining for coal and iron is unsustainable as once these resources are removed from the ground they are gone. In order to continue being economically viable, mining companies must relocate. Other impacts make the mining industry unsustainable. Groundwater contamination and pollution from the fracking industry could be considered irreversible, based on our life-times. Climate change is increasing, due to the combustion of fossil fuels and some disasters (e.g. Deepwater Horizon oil spill) cause pollution on a very large scale that remains for decades.

#### Comments

- (a) *Answers were not limited to the above and only a few candidates disagreed with the quote. Candidates who disagreed and provide credible points were awarded full marks. For example; LEDCs have a much smaller energy requirement and per person their ecological footprint is much smaller than that of a MEDC. Small island nations (LEDCs) often depend on the ocean and land for their survival and thus have a more traditional and sustainable lifestyle and do not contribute to greenhouse gas emissions, like the MEDCs. Economic instability does not always lead to environmental unsustainability, but varies with each country.*
- (b) *This question was answered poorly as many candidates just simply stated that extractive industries were unsustainable since the coal or iron would run out. More detail was required for full marks. A great range of answers were accepted. Almost all answers detailing some sort of environmental damage from mining, or how mining is not sustainable, were accepted. Answers that commented upon Australia needing to move from mining towards renewables, or other technology in order to remain economically viable, were also accepted.*

#### Question 24

- (a) (i) Inter-generational Equity
- (ii) Many possible answers to this question, examples could include:
- Establishing and managing parks and reserves and marine protected areas allows biodiversity to flourish for future generations.
  - Establishing a carbon tax or an emission trading scheme like in Europe, to decrease emissions and the effects of global climate change
  - Economic incentives like rebates for installing solar panels or switching to electric cars/bikes.
  - Economic incentives like funding for other renewables combined with disincentive to use fossil fuels.
  - Implementing a container deposit scheme in all states not just SA and NSW so that our resources are used more efficiently with less littering
  - Advertising and educating the public about plastic waste
  - Reducing the amount of debris entering the ocean through litter traps on rivers, use only canvas/hessian/cotton shopping bags, ban the sale of micro-plastics in facial scrubs, filters on washing machines to reduce micro-plastics, support projects to remove marine debris in the gyres (Ocean Cleanup).
  - Laws or other targets to limit pollution or emissions for example ratifying the Paris Accord and Renewable Energy Targets
  - Carbon offsets.
- (b) An educated consumer would choose to purchase sustainably harvested seafood or wood products by looking for the MSC (Marine Stewardship Council) or FSC (Forest Stewardship Council) ticks of approval. This gives more money to a sustainably harvested fishery and thus in the long run their business is profitable and successful. With less money flowing to an unsustainable fishery this business would be forced to either close or change their practices.

#### Comments

- (a) (i) *Answered very well almost all candidates achieved 1 mark.*

(ii) *Either two well explained points or four different brief points were awarded full marks. Very well answered as almost any sustainability strategy was accepted. Half marks were awarded if the sustainability principles were given (eg. Intra-generational equity, Precautionary Principle etc.) without examples, as the question was about strategies.*

(b) *This question was well answered although some candidates mentioned laws and other actions that were not suited to a consumer, so were awarded half marks. For full marks, the answer needed to include both education and economic aspects in the situation. As there were a great many possible and correct answers this aided candidates to achieve high marks. A popular answer was the choice educated consumers make to use calico vs. single-use plastic grocery bags.*

### Question 25

- (a) The developer (proponent) pays for the EIA but the actual data gathering and writing is performed by experts in their fields/consultants/environmental scientists.
- (b) The EIA focusses on alterations to designs and the environmental impacts of a proposed development or project, whereas a Management Plan is concerned with management and environmental impacts of already established developments, activities, threatened species or parks and reserves.
- (c) Many possible answers to this question, examples could include:
- Proposed development is possible legally under current management plan and sympathetic with vision of National Park.
  - Minimal environmental impact of clearing area/ski fields to flora and fauna and threatened species.
  - Community acceptance of increased traffic, increased tourists and changes these will bring to community and local businesses.
- (d) Ecological Integrity/Conservation of Biodiversity.

### Comments

- (a) *Well answered.*
- (b) *Very well answered although it should be noted that EIAs and EMPs both involve stakeholders and a social license.*
- (c) *Answered very well although candidates who copied the info booklet without any adjustments to the Ben Lomond situation received half marks. Answers that were very vague and made broad statements such as the 'environment should not be harmed' were given no marks.*
- (d) *Well answered. The principles of Inter-generational Equity, Intra-generational Equity and the Precautionary Principle were also given full marks.*

### Question 26

- (a) Externality. An example would be when milk processors are not required to pay for the disposal of milk cartons (thus the consumer does not pay), the local council meets this cost.
- (b) (i) Economic: the cost of building and operating will need to be considered. Will there be enough customers? Will it be worthwhile and make a profit? Otherwise it is not feasible and should not be built.
- (ii) Examples of environmental impacts and a consideration could be the:
- Water quality impacts upon the estuary and coastal waters from irrigation, herbicides and pesticides.
  - Stability of the sand dunes and impacts from sea level rise.
  - Threatened species in the areas should not be impacted.
  - Removal of vegetation and bush for the fairways and the impacts of this habitat loss.

- Sand dune erosion and alteration of the sand dune environment on coastal and migratory species.

All of these impacts need to be minimised to maintain the biodiversity and ecosystem services of this coastal environment.

- (iii) Social: All the stakeholders need to accept or approve the development for its continuing success and smooth running (Intra-generational Equity). Considerations could include:
- Loss of access to the area and its current use to the community.
  - The locals may be concerned about more traffic and parking issues.
  - The locals may be unsure about more people/tourists using 'their' beach.
  - Locals may be unsure about alteration to the views (aesthetics) from their homes and beach views.
  - Locals may be concerned if there are aboriginal heritage areas where the golf course will be developed.
  - There may be local businesses that are worried about competition i.e. the current golf course.
  - Changes to land values from the development upon neighbouring properties.
  - The local horse riding club may lose horse exercise areas.

#### Comments

- (a) *This was very poorly answered as most candidates did not know this was an externality, although half a mark was given for a correct example. The milk carton example was given in the information booklet and was given full marks.*
- (b) *This question was answered moderately well; although being the last question in the booklet some candidates ran out of time. There were a great many possible and correct answers and this aided candidates to achieve high marks.*