

Section One: Multiple-choice

30% (30 Marks)

This section has **30** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade a box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 40 minutes.

1. The biological classification of organisms into their appropriate taxon is based on which of the following factors?
 - (a) The ability to interbreed and produce offspring with similar morphology.
 - (b) Production of fertile offspring, metabolism and evolutionary relatedness.
 - (c) Genes, anatomical structures and symmetry.
 - (d) Physical features, molecular sequences and modes of reproduction.

2. Which of the following scenarios best represents primary succession?
 - (a) Emergence of weeds on disturbed soil.
 - (b) Lichen growing on a newly formed volcanic island.
 - (c) Germination of seeds following wildfire.
 - (d) Birds making nests in tree hollows within an old growth forest.

3. Populations of organisms differ in the way they are distributed throughout the environment. The most significant factor influencing the distribution of organisms is
 - (a) resource availability.
 - (b) predation.
 - (c) territorial disputes.
 - (d) birth rate.

4. The carrying capacity of any species in its natural environment is best defined as the
 - (a) point at which birth rate and immigration is equal to death rate and emigration.
 - (b) maximum number of individuals that an ecosystem can sustainably support.
 - (c) indefinite availability of resources required for ongoing survival.
 - (d) the minimum number of organisms that can be supported by any ecosystem at any one time.

Refer to the image below to answer question 5.



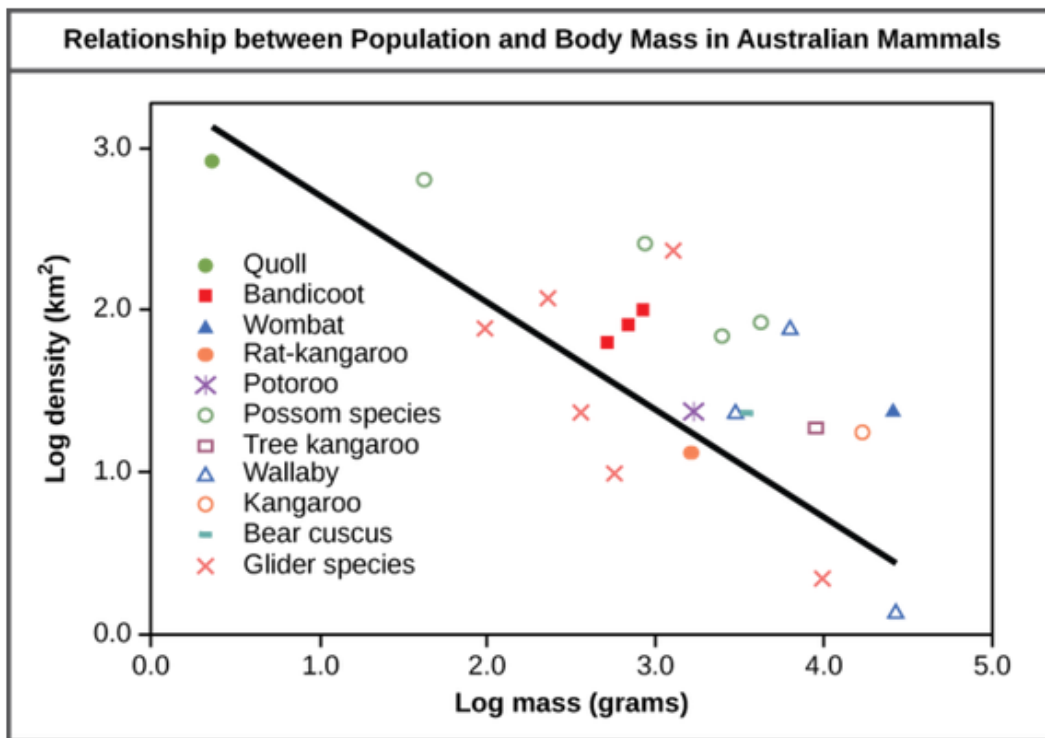
5. The image above shows a species of mistletoe (*Amyema maidenii*) growing on an Acacia tree in central Australia. The mistletoe has modified roots that penetrate the stem of the tree to obtain water and nutrients. Mistletoe usually colonise on plants that have suffered some form of stress from disease, drought or fire. They are not solely responsible for the death of a plant. This type of ecological interaction is best described as
- (a) commensalism.
 - (b) predation.
 - (c) collaboration.
 - (d) parasitism.
6. Loggerhead turtles (*Caretta caretta*) visit the beaches of northern Western Australia to nest and lay eggs. The activities of the surviving hatchlings are a mystery to marine scientists; the turtles do not reappear for up to 15 years. The most effective monitoring technique to reveal turtle activity and behaviour to scientists would be
- (a) remote satellite sensing.
 - (b) capture-recapture method.
 - (c) GPS or radio-tracking.
 - (d) drone technology.
7. Binomial nomenclature refers to the process by which every organism is assigned a
- (a) taxonomic number.
 - (b) common name based on two individual characteristics.
 - (c) Latin name.
 - (d) two-part scientific name.

Refer to the image below to answer questions 8 and 9.



8. The growth pattern of the branches on the *Banksia* tree pictured above are produced from
- (a) lignotubers.
 - (b) epicormic buds.
 - (c) specialised, photosynthetic bark cells.
 - (d) rhizome buds.
9. This particular growth pattern occurs in response to an environmental disturbance. In Australian ecosystems, this disturbance is most likely
- (a) flooding.
 - (b) fire.
 - (c) salinity.
 - (d) drought.
10. Ecologists often measure and calculate the number of individuals of a species in a given area. Which of the following terms best describes this data?
- (a) Population density
 - (b) Population size
 - (c) Population diversity
 - (d) Species abundance

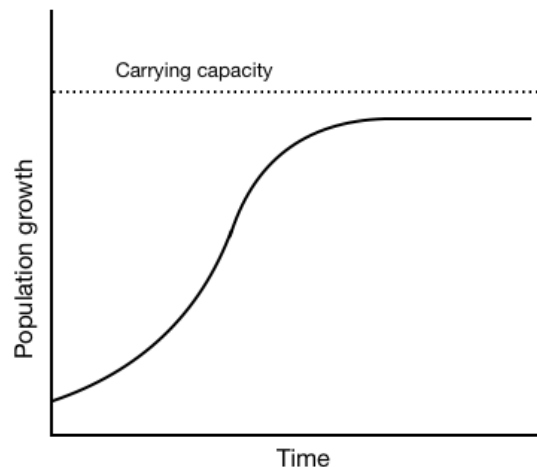
Refer to the graph below to answer questions 11 and 12.



11. Which of the following hypotheses best reflects the data presented in the graph above?
- (a) Body mass will increase as population density increases.
 - (b) Population density will increase in response to body mass change.
 - (c) Body mass will decrease as population density increases.
 - (d) Body mass will increase in response to lower population density.
12. Population studies are influenced by many biotic and abiotic factors in the environment. Which of the following factors could have influenced the reliability of the data collected in this investigation?
- (a) Type of habitat, food and water availability and weather.
 - (b) Presence of offspring, nocturnal behaviour and habitat disruption.
 - (c) Burrowing behaviour, rainfall and climate change.
 - (d) All of the above.
13. Which of the following attributes of a flowering plant would allow a population to increase its geographical distribution?
- (a) Wind pollination.
 - (b) Seed dispersal via bird vectors.
 - (c) Year-round flowering period.
 - (d) Habitat specialisation.

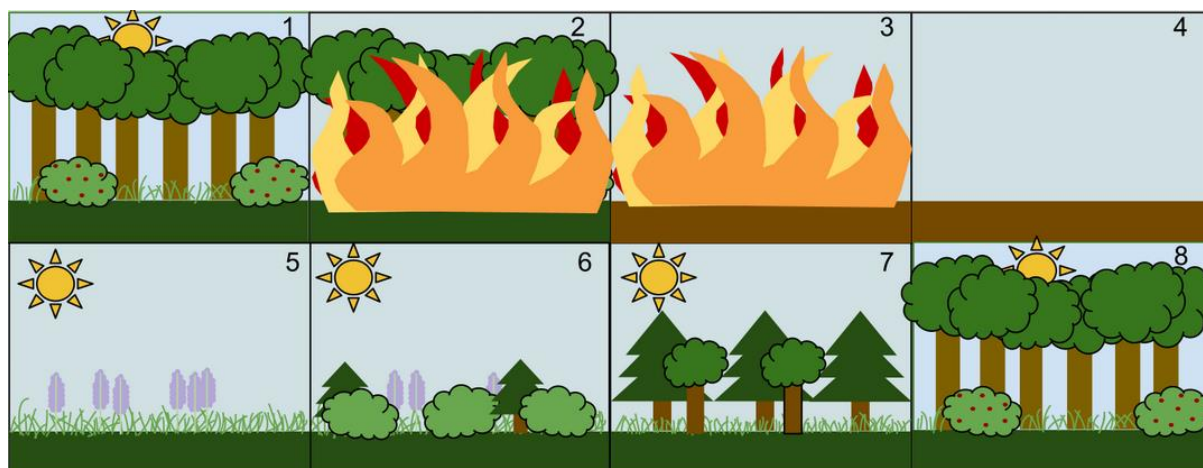
14. Primary productivity of terrestrial ecosystems found in tropical climates is greater than in temperate climates. Which of the following statements best outlines the reason for this difference?
- (a) Inorganic nutrients are more readily available in tropical ecosystems than in temperate ecosystems.
 - (b) The level of carbon dioxide in the atmosphere is greater in tropical terrestrial ecosystems due to slash and burn forestry.
 - (c) The rate of photosynthesis is higher in the tropics due to the increased availability of water and light.
 - (d) The relative number of herbivorous species is greater in temperate terrestrial ecosystems.
15. A large geographical area distinguished by a dominant form of vegetation is known as a/an
- (a) ecosystem.
 - (b) biome.
 - (c) habitat.
 - (d) community.
16. Giant kelp is able to absorb large amounts of CO₂ from its surrounding aquatic habitat. However, the kelp is consumed by large sea urchins that are able to chew through the kelp's tough anchor point. While marine biologists were investigating this phenomenon, they discovered that sea otters were feeding on the urchins, thereby keeping the population in check. In this scenario, the sea otter is considered to be a
- (a) predator.
 - (b) competitor.
 - (c) keystone species.
 - (d) consumer.
17. An environmental element that can restrict the survival of an organism to a particular region is most often referred to as a/an
- (a) climatic factor.
 - (b) abiotic factor.
 - (c) dependent factor.
 - (d) limiting factor.
18. The cane toad, introduced in 1935, has become a destructive pest across northern Australia. Which of the following does not offer an explanation for their ongoing success?
- (a) Lack of competition.
 - (b) Expansive geographical and climatic range.
 - (c) Production of poison from specialised glands.
 - (d) High reproduction capacity.

The graph below refers to question 19.



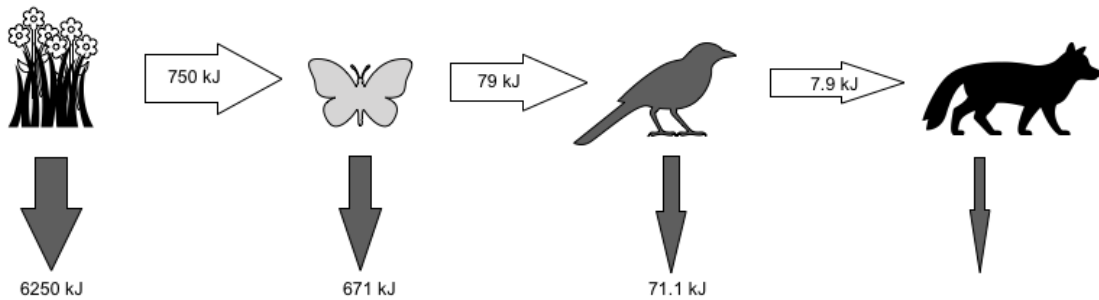
19. The graph shown above represents the population growth pattern of an organism. Which of the following population characteristics cannot be applied to this organism?
- (a) Production of many offspring.
 - (b) Long life span.
 - (c) Controlled by density-dependent factors.
 - (d) Adult form of the organism is relatively large.
20. Eutrophication of natural waterbodies can often eventuate in fish kills. Fish deaths are the direct result of
- (a) poisoning from toxic cyanobacteria.
 - (b) reduced food availability.
 - (c) depletion of dissolved oxygen in the water.
 - (d) reduced light penetration through the water column.
21. The release of excessive chlorofluorocarbons and hydrocarbons into the atmosphere over the past 60 years has caused which environmental problem?
- (a) Acid rain
 - (b) Ozone layer depletion
 - (c) Enhanced global warming
 - (d) Ocean acidification
22. A chemical component of bushfire smoke is crucial to the survival of some Australian native plant species. The addition of this chemical to water, termed 'smoky water', has enabled researchers to grow many more native species for the commercial market because it stimulates
- (a) photosynthesis.
 - (b) flowering.
 - (c) root formation.
 - (d) germination.

The diagram below refers to questions 23 and 24.



23. Which ecological phenomenon is represented by the diagram above?
- (a) Bushfire
 - (b) Primary succession
 - (c) Secondary succession
 - (d) Ecological disturbance
24. The plants pictured in boxes 5 and 6 of the diagram are termed
- (a) perennial species.
 - (b) pioneer species.
 - (c) intermediate species.
 - (d) colonial species.
25. Scientists classify ecological systems into five distinct, hierarchical levels, allowing them to better understand their dynamic nature. Which of the following shows these hierarchical levels in order from specific to broad?
- (a) Biosphere, ecosystem, niche, habitat, species.
 - (b) Niche, ecosystem, population, community, organism.
 - (c) Organism, population, community, ecosystem, biosphere.
 - (d) Cells, organism, population, community, biome.
26. Biomass is a measure of
- (a) the mass of all living organisms in a given area at a given time.
 - (b) energy transfer through the trophic levels of a food chain.
 - (c) the primary productivity of a functional community.
 - (d) all the organisms in a particular ecosystem at a given time.

The diagram below refers to questions 27 and 28.



27. Energy transfer efficiency between trophic levels can be calculated using the formula;

$$\text{Energy transfer efficiency} = \frac{\text{Energy transferred between levels}}{\text{Total energy in consumed level}} \times 100$$

What percentage of energy from the butterfly is transferred to the bird?

- (a) 12%
 - (b) 10.5%
 - (c) 10%
 - (d) 0.01%
28. The energy that is not transferred from butterfly to bird in this food chain is
- (a) kept within the butterfly population to maintain the energy levels of the food chain.
 - (b) divided up amongst other consumers in other food chains.
 - (c) lost through decomposition of dead butterflies.
 - (d) lost through heat and to metabolic processes and decomposers.
29. The pygmy bluetongue skink (*Tiliqua adelaidensis*) is only found in a restricted region of grassland near Adelaide, where it inhabits old spider burrows for protection and reproduction. There are estimated to be around 5000 individuals left in these grasslands. Which of the following population growth factors would likely be zero?
- (a) Emigration
 - (b) Immigration
 - (c) Birth
 - (d) Death
30. Given its location and habitat, what is the greatest threat to the pygmy bluetongue skink's survival?
- (a) Urban and agricultural expansion.
 - (b) Bushfires.
 - (c) Spider bites.
 - (d) Predation by feral cats and foxes.

End of Section One

Section Two: Short answer

50% (100 Marks)

This section has **five (5)** questions. Answer **all** questions. Write your answers in the spaces provided in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided. Use a blue or black pen for this section. Only graphs and diagrams may be drawn in pencil.

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

Suggested working time: 90 minutes.

Question 31

(20 marks)

The number of carbon atoms present in and around the Earth has not changed since its formation.

- (a) Identify the form and process through which carbon enters a food chain. (2 marks)

- (b) Explain how humans are altering the ratio of carbon atoms between the Earth, the ocean and the atmosphere. (4 marks)

Of the excess carbon that is released into the atmosphere each year, only half is sequestered back into abiotic and biotic 'sinks'.

(c) Suggest why this excess carbon cannot be stored or trapped within the usual carbon cycle 'sinks'. (2 marks)

(d) Describe how excess carbon within the Earth's atmosphere has affected the biotic and abiotic factors in our terrestrial and aquatic ecosystems. Use a diagram to support your answer. (8 marks)



(e) Describe **two (2)** ways in which our governments and communities can help to reduce the release of excess carbon into the atmosphere each year. (4 marks)

Question 32

(20 marks)

The Woylie (*Bettongia penicillata*) is a small, native marsupial also known as a brush-tailed bettong. Woylies were once widespread across the Australian landscape. In the 1960's the woylie population suffered a devastating crash, leaving only a few hundred individuals representing the entire species. This remnant population was restricted to three main areas within the southwest of Western Australia - Dryandra, Tutanning and Upper Warren (see map below).

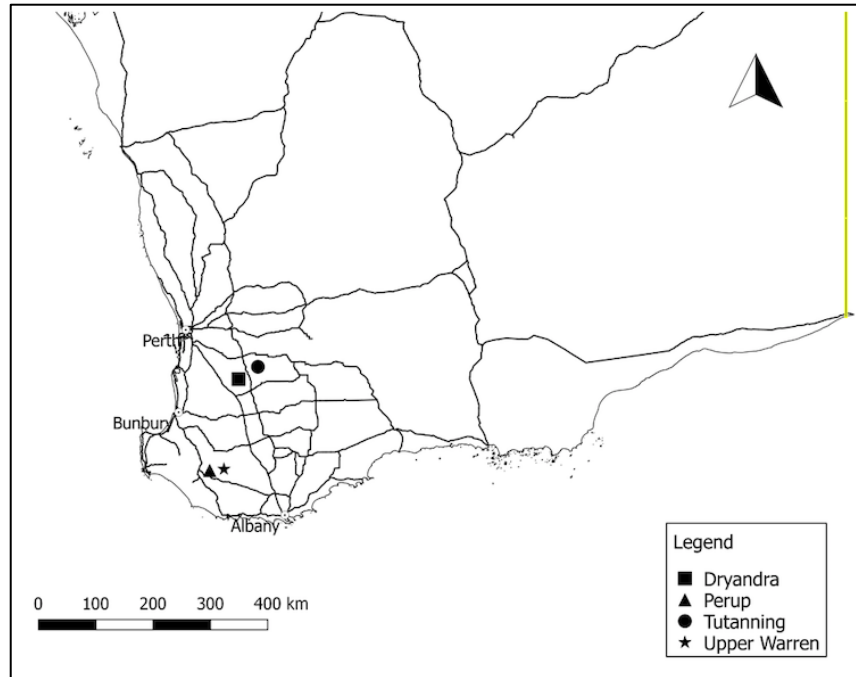


Figure 5 - Location of Woylie populations in Western Australia.

The Woylie was added to both the state and commonwealth threatened species list. Following conservation efforts, the Woylie population began to recover in the 1970's and was delisted as a threatened species in 1996. By 2000, scientists estimated that the natural population of Woylies had reached approximately 200,000 individuals. Suddenly, and for reasons unknown to the scientists involved, the population underwent another dramatic crash. The Woylie was listed as Critically Endangered and by 2010, 90% of the population had disappeared. For those individuals that remained, many were found in poor condition, intensified by parasitic infections. The time had come for a new approach to their ongoing survival.

- (a) The southwest region of Western Australia is classified as a 'Biodiversity Hotspot'. State the requirements for an ecosystem to be considered a Biodiversity Hotspot. (3 marks)

By meeting requirements as a Biodiversity Hotspot, organisms inhabiting southwest ecosystems could be adversely affected.

- (b) Explain the possible impacts on the Woylie populations in the southwest region of Western Australia. (3 marks)

As an 'insurance policy' against Woylie extinction, a 423-hectare, captive-breeding sanctuary was established in Perup in the southwest, in 2010. 1700km of predator-proof fencing was erected and all feral species were baited or trapped and removed from the area. Prior to the translocation and release of Woylies into Perup sanctuary, all other native animals were mustered from the sanctuary by researchers and volunteers.

- (c) Explain the reasoning behind the removal of other native animals from Perup sanctuary. (2 marks)

41 adult Woylies were captured from other habitats around the southwest to populate the sanctuary.

- (d) Outline the appropriate, field-based procedure that researchers would follow to capture the Woylies for translocation. (6 marks)

Of the 41 Woylies placed into Perup sanctuary, 20 were female and 21 were male.

- (e) Suggest **two (2)** factors that must be considered when selecting individuals for a breeding population. (2 marks)

Within three years of the sanctuary being established, the Woylies were found to be breeding successfully, with all females having produced at least one litter. In 2013, researchers added another 36 Woylies to Perup sanctuary to 'top up' the population.

- (f) Explain the importance of introducing new individuals into the breeding population over time. (2 marks)

- (g) Identify **two (2)** problems associated with releasing captive-bred animals into their 'natural' habitat. (2 marks)

Question 33

(20 marks)

- (a) Outline **two (2)** reasons why scientists classify organisms. (2 marks)

The list below contains **eight (8)** scientific names from members of the bird family Psittacidae.

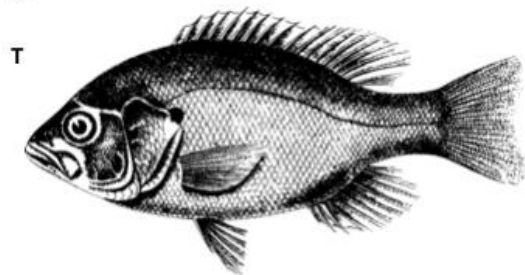
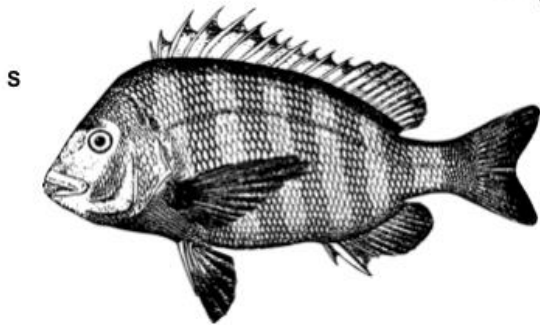
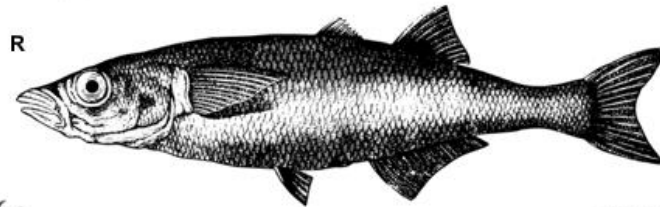
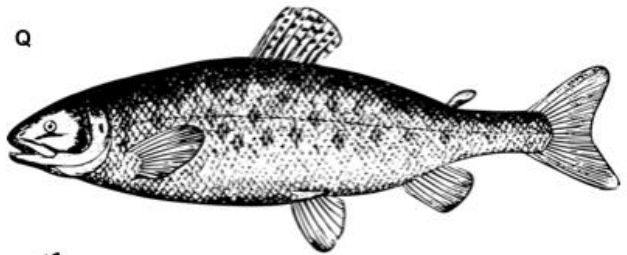
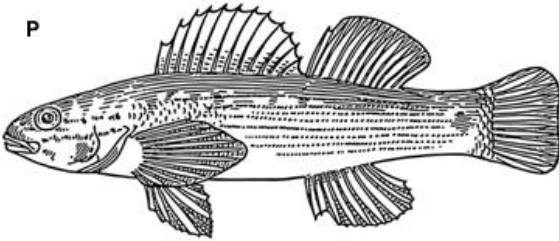
- Psittacus erithacus*
- Pyrilia vulturina*
- Glossopsitta pusilla*
- Trichoglossus haematodus*
- Psittichas fulgidus*
- Pyrilia haematotis*
- Melopsittacus undulatus*
- Polytelis alexandrae*

- (b) Identify the **two (2)** most closely related birds from the list above. (2 marks)

- (c) Explain why these two birds were chosen. (1 mark)

- (d) Define the term 'dichotomous key' and explain how it is used by scientists. (3 marks)

Consider the fish (P, Q, R, S and T) below.



(e) Identify the **five (5)** fish using the dichotomous key below.

(5 marks)

- P _____
- Q _____
- R _____
- S _____
- T _____

- | | |
|---|-----------|
| 1a Elongated body..... | go to 2 |
| 1b Body not elongated..... | go to 3 |
| 2a Dorsal (back) fin is split in two..... | go to 4 |
| 2b Dorsal (back) fin is not split (whole)..... | Species 1 |
| 3a Mouth is curved downwards..... | Species 2 |
| 3b Mouth is not curved downwards..... | Species 3 |
| 4a Tail is forked and pointed..... | Species 4 |
| 4b Tail is not forked and pointed..... | Species 5 |

(f) Identify **four (4)** major morphological characteristics that are used to classify animals into their appropriate phylum. (4 marks)

- (i) _____
- (ii) _____
- (iii) _____
- (iv) _____

Ecological communities, containing a host of different organisms living together, can also be classified.

(g) Outline how ecosystems are classified or named. (2 marks)

(h) Suggest why it is essential for scientists to classify ecosystems. (1 mark)

Question 34**(20 marks)**

Doug the horticulturalist was trialling a new, 'non-toxic' pesticide for a chemical company to prevent aphids destroying his broccoli crops. Unlike other pesticides, the trial chemical is applied to the soil around newly planted seedlings. The active ingredient in the pesticide is taken up by the plant's roots and distributed throughout its transport system. Any aphids that try to feed from the plant's sap will find it unpalatable and fly away unharmed.

Doug chose four rows in his market garden in which to carry out the trial. In each row, 100 broccoli seedlings were planted as normal. The 'treatments' applied to the rows are as follows;

Row 1 - water only.

Row 2 - fertiliser (ammonium phosphate) and water.

Row 3 - fertiliser (ammonium phosphate), water and trial pesticide.

Row 4 - water and trial pesticide.

Every three days, over a three-week period, Doug collected soil samples (as instructed) and plant height measurements. He also observed the overall condition of the broccoli seedlings and presence of aphids. The measurements were taken from 20 randomly selected plants from each row. The soil samples were collected from the area around the plants. They were then sent to the chemical company for analysis of nitrate content.

Doug's final results are displayed in the tables below.

Table 1 - *Aphid pesticide trial on broccoli seedlings - plant height, condition and aphid activity.*

Day	Mean plant height (cm)				Plant condition / aphid activity			
	Row 1	Row 2	Row 3	Row 4	Row 1	Row 2	Row 3	Row 4
0	5.1	4.9	5.2	5.2	G / N	G / N	G / N	G / N
3	5.3	5.8	5.7	5.9	G / N	G / N	G / N	G / N
6	5.9	6.7	7.1	6.8	G / N	G / N	G / N	G / N
9	7.2	9.2	8.5	7.5	G / N	G / N	G / N	A / N
12	8.8	10.1	9.8	9.0	G / L	G / L	A / N	A / N
15	10.6	12.6	12.1	9.5	G / L	G / L	A / N	A / N
18	13.2	15.8	14.7	10.3	A / M	G / L	A / N	A / N
21	14.7	19.3	16.2	11.9	A / M	G / L	A / N	B / N

**Plant condition*

G = good

A = average

B = below average

**Aphid activity*

H = high

M = medium

L = low

N = none

Table 2 - Nitrate content of test soils in parts per million (ppm).

Day	Nitrates (NO ₃ ⁻) ppm			
	Row 1	Row 2	Row 3	Row 4
0	28	32	30	31
3	29	35	34	30
6	27	40	38	31
9	28	42	32	25
12	26	44	27	22
15	25	50	21	14
18	22	51	16	10
21	23	56	8	4

- (a) Propose an appropriate hypothesis for this investigation. (2 marks)

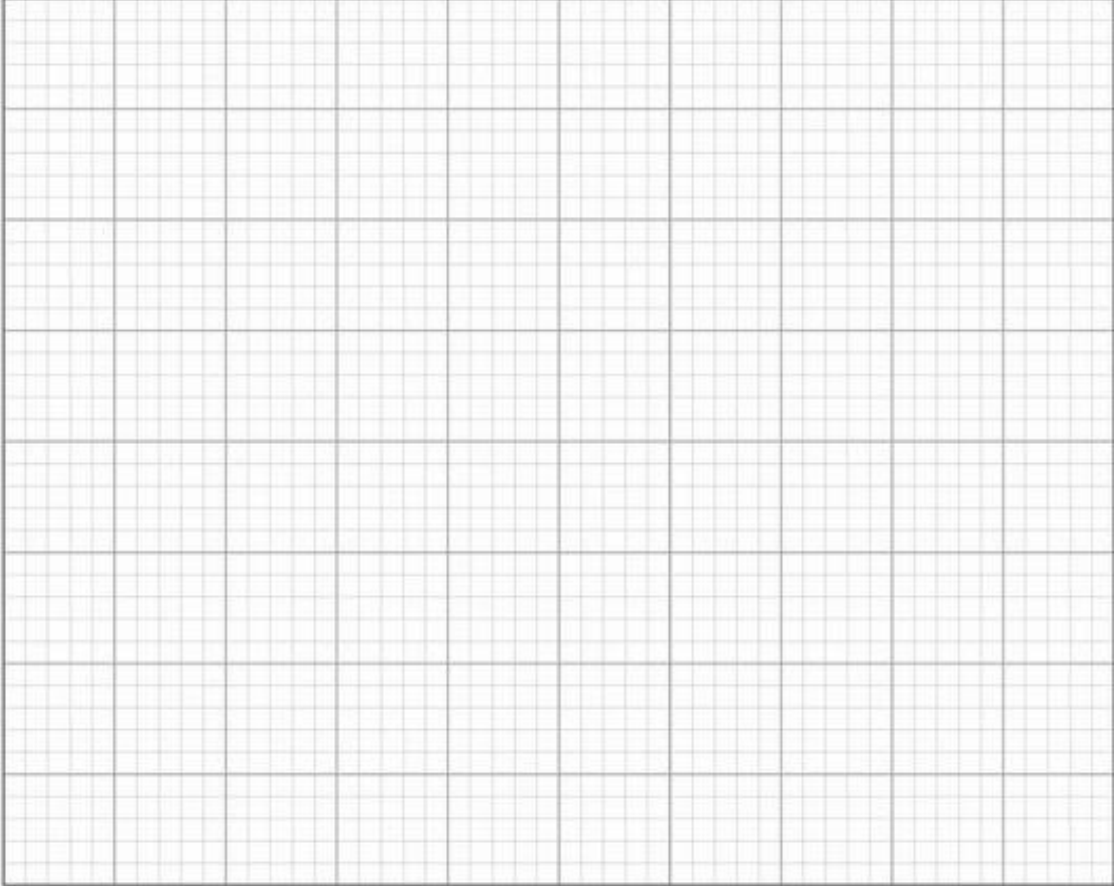
- (b) Identify the following variables in the investigation. (2 marks)

(i) Independent _____

(ii) Dependent _____

- (c) Suggest **two (2)** variables that needed to be controlled during this investigation. (2 marks)

(d) Construct an appropriate graph, in the space provided, using mean plant height data from Table 1. (5 marks)



(e) Comment on any patterns or relationships in the graphed data that you may have found unexpected. (3 marks)

Doug received further information from the chemical company regarding the analysed soil samples. Unfortunately, they found that the new pesticide killed soil bacteria responsible for nitrification.

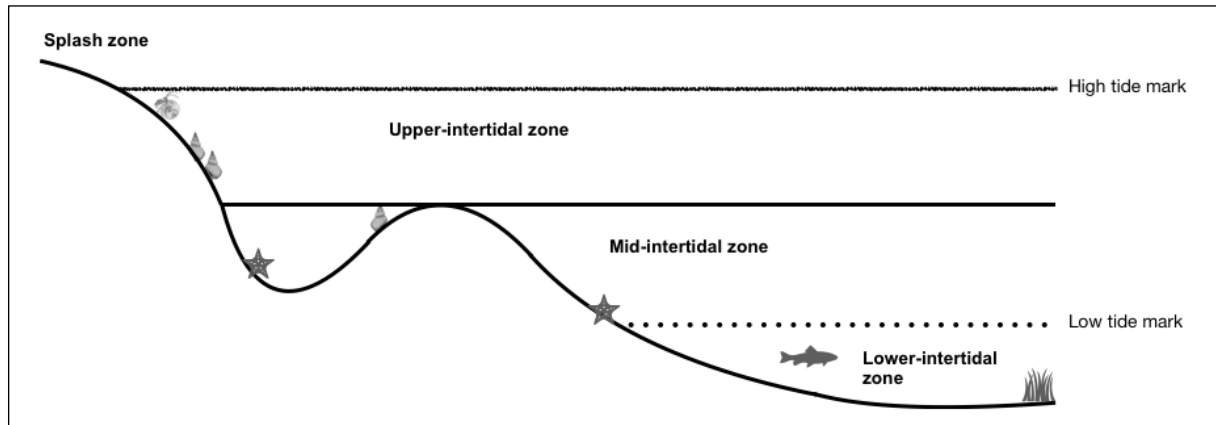
(f) Explain how the loss of nitrifying bacteria has affected the cycling of nitrogen in the soil and plant growth. Use the data in Table 2 to help formulate your response. (4 marks)

(g) Indicate whether the data collected in this investigation met Doug's original aim; "Will adding pesticide to prevent aphid attack increase the growth of broccoli seedlings?" (2 marks)

Question 35

(20 marks)

Every coastline in the world supports a dynamic and unique ecosystem - the intertidal zone. The intertidal zone is the area between high and low tide marks along the shoreline. This ecosystem is often referred to as a rocky shore, however it can also include mangrove forests and mudflats. The diagram below shows the distinct zones of these ecosystems.

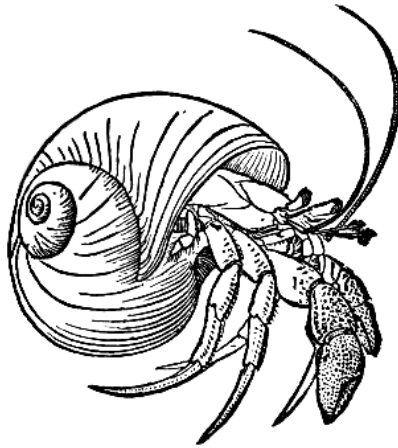


- (a) Complete the table below by explaining the dynamics of each abiotic factor in the intertidal zone. (4 marks)

Abiotic Factor	Explanation of Influence
Temperature	
Water/moisture	
Salinity	
Wave action	

- (b) The intertidal zone is an incredibly harsh environment, yet it is highly diverse. Suggest **two (2)** benefits (to an organism) of living in this ecosystem. (2 marks)

The upper-intertidal zone is often characterised by an abundance of hermit crabs (see image below).



- (c) Explain this pattern of distribution of the hermit crab. (2 marks)

- (d) The abundance of primary producers is greatest in the lower-intertidal zone. Explain this phenomenon. (3 marks)

- (e) Humans pose the greatest threat to life in the intertidal zone. Discuss **three (3)** human activities and/or environmental problems with the potential to threaten the diversity, habitat and interactions between organisms of intertidal zones. (6 marks)

Many coastal and marine ecosystems in Australia lie within the confines of marine parks that are regulated by state government legislation. While the conservation of biodiversity is a priority in ecosystem and park management, recognition of Indigenous Australians as the traditional custodians is essential.

- (f) Suggest why marine park management should involve significant input from the local Indigenous community. (3 marks)

End of Section Two