

MATRIC LIFE SCIENCES PAPER 2

Environmental studies; Diversity, change and continuity

SECTION A QUESTION 1

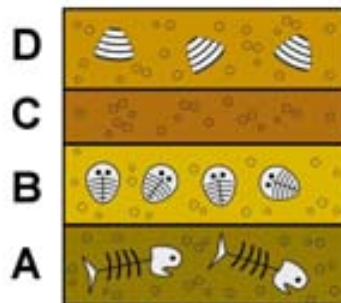
1.1 Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5), for example 1.1.11 D.

1.1.1 There is little fossil evidence of the earliest forms of life because the organisms

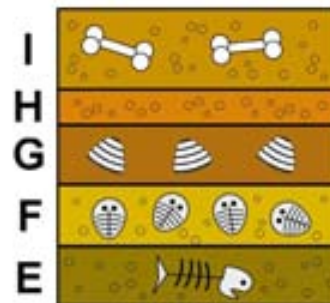
- A. decayed quickly in the oxygen-rich atmosphere
- B. did not have hard parts that would fossilise easily
- C. evolved so quickly that they left few remains
- D. lived in water and were not preserved.

1.1.2 The diagrams below represent sedimentary rock strata from two different palaeontological sites. Based on these diagrams it would be reasonable to conclude that fossils in

Rock strata from location 1



Rock strata from location 2



- A. stratum B are the same age as fossils in stratum E
- B. stratum A are younger than fossils in stratum E
- C. stratum D are younger than fossils in stratum F
- D. stratum I are older than fossils in stratum G.

1.1.3 Possible measures for the reduction of air pollution would NOT include

- A. providing subsidies for solar panels
- B. providing subsidies for truck drivers
- C. rewards for cleaner production by industries
- D. improving the public transport system.

1.1.4 With which of the following scientists is the concept “survival of the fittest” associated?

- A. Jean-Baptiste Lamarck
- B. Hans Krebs

- C. James Watson
D. Charles Darwin

Mesosaurus was a giant reptile that lived about 270 million years ago. The average *Mesosaurus* measured about one metre in length, had webbed feet, a long tail and many sharp teeth. Fossils of *Mesosaurus* have been found in only two places: the eastern side of South America and the western side of South Africa.

- 1.1.5 The distribution of the fossil remains is evidence of
A speciation
B continental drift
C natural selection
D divergent evolution.

5 x 2 (10)

- 1.2 Give the correct biological term for each of the following descriptions. Write only the term next to the question number (1.2.1–1.2.5).

- 1.2.1 The simultaneous elimination of a large number of species on a worldwide scale
1.2.2 A change in the structure or function of an organism to suit the conditions, thus increasing its chances of survival
1.2.3 Numerous interacting food chains that show the feeding relationships in an ecosystem
1.2.4 The whole variety of living things found in a defined environment
1.2.5 The arrangement of having five digits on front and hind limbs

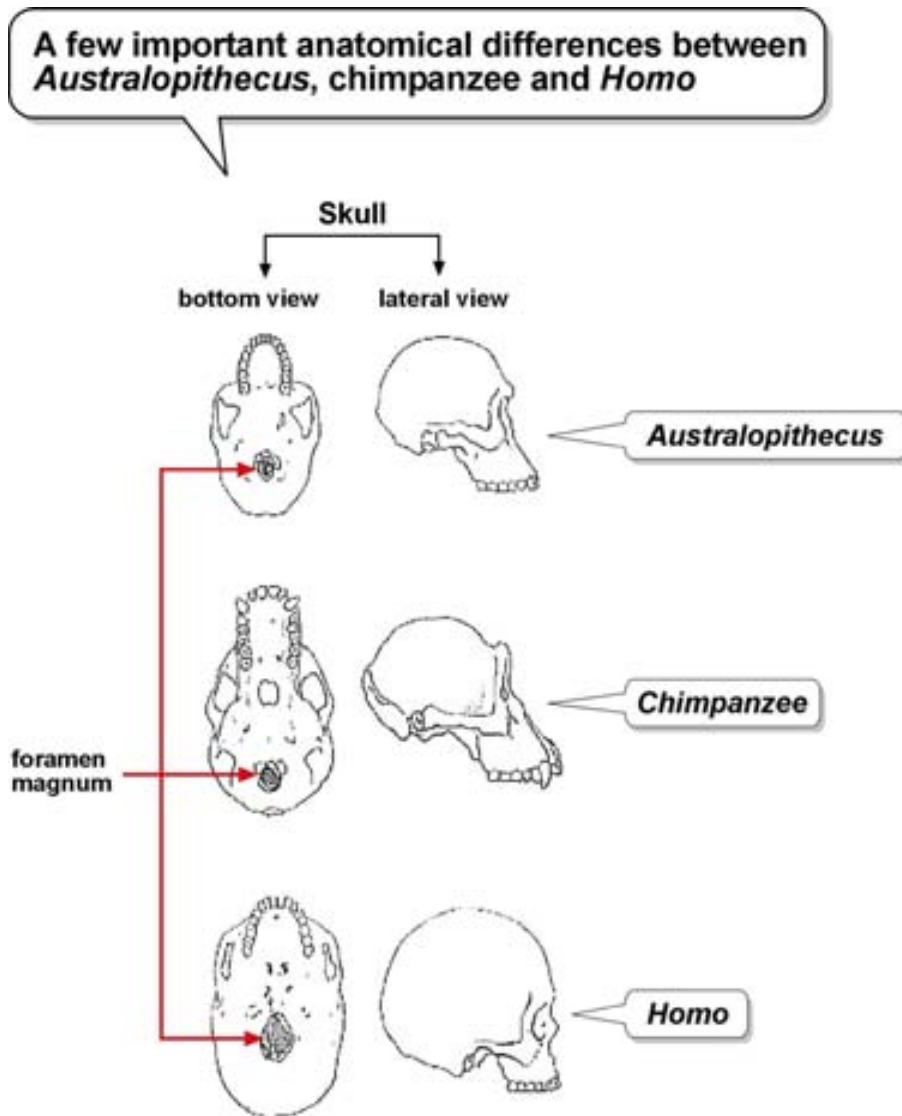
5 x 1 (5)

- 1.3 Choose an item from COLUMN II that matches a statement in COLUMN I. Write only the letter (A–G) next to the question number (1.3.1–1.3.6), for example 1.3.6 J.

| | COLUMN I | COLUMN II |
|-------|---|------------------------------|
| 1.3.1 | Slow changes in the characteristics of a species over time that are not enough to form a new species but keep it well suited to its environment | A homologous |
| 1.3.2 | The driver for development of two different species with similar features owing to convergent evolution | B micro-evolution |
| 1.3.3 | A change in the gene frequency not caused by the environment or sexual choice, but due to accidental changes in a small population | C geographical isolation |
| 1.3.4 | The process that acts on an organism's genotype to bring about evolution | D analogous |
| 1.3.5 | The non-living factors of an ecosystem | E natural selection |
| 1.3.6 | Structures that appear different but have a similar evolutionary origin | F abiotic G genetic drift |

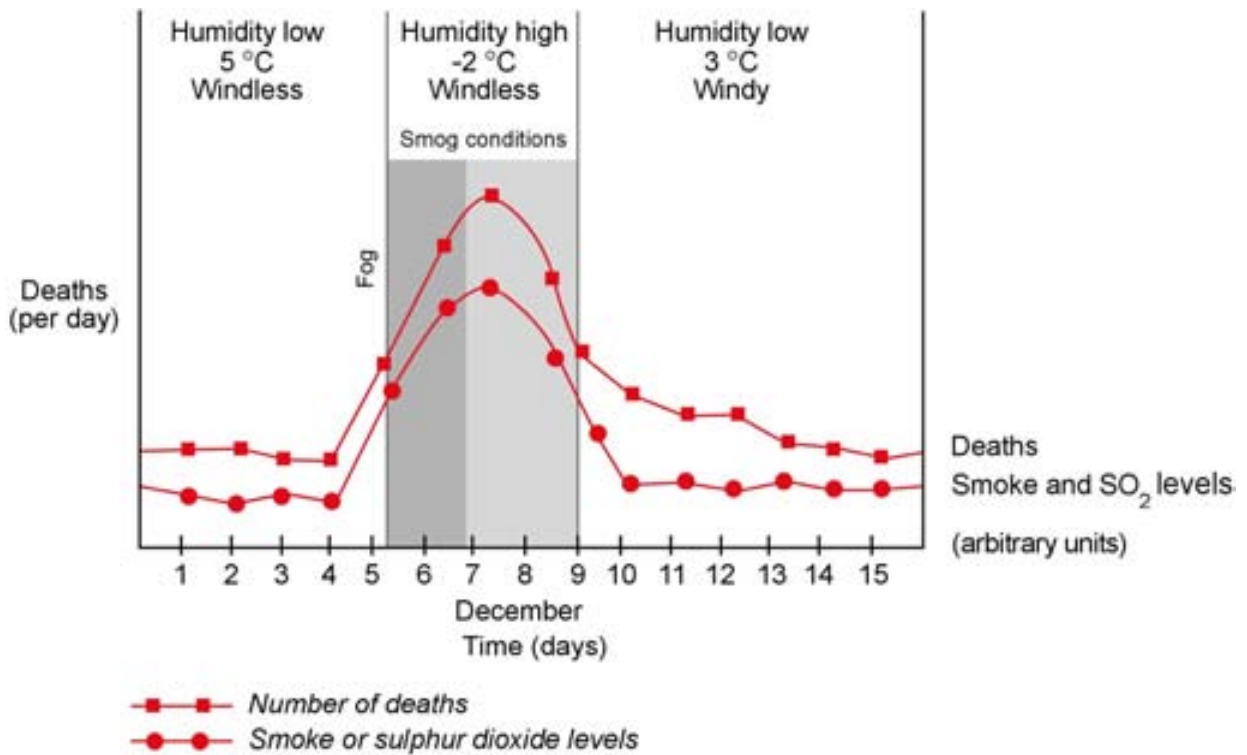
6 x 1 (6)

- 1.4 A comparison of the anatomical features of organisms has helped scientists to propose evolutionary relationships.



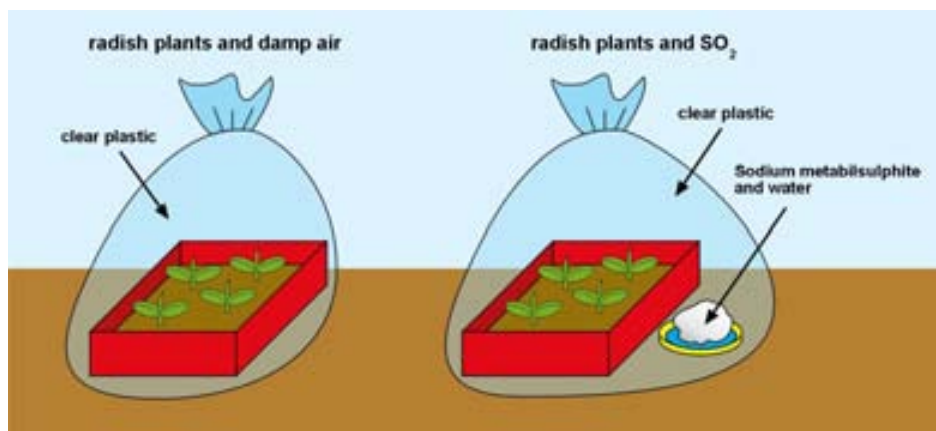
- 1.4.1 Tabulate THREE observable differences between the side view of the skulls of *Homo* and the chimpanzee. (7)
- 1.4.2 Which of the three organisms, other than *Homo* (i.e. *Australopithecus* or chimpanzee), was/is not bipedal? (1)
- 1.4.3 Give ONE observable feature shown in the above figure to support your answer in question 1.4.2. (2)
- 1.4.4 Name TWO fossils of the *Australopithecus* genus found in South Africa. (2)

1.5 The graph below shows details of the great London smog of 1952.



- 1.5.1 In the period shown, approximately how many extra deaths occurred at the height of the smog period compared to deaths in periods without smog? (1)
- 1.5.2 From the information provided in the above figure, list FOUR environmental conditions that contributed to the formation of smog. (4)
- 1.5.3 Suggest why the levels of smoke and sulphur dioxide (SO₂) started to rise before the smog formed. (2)

A pupil thinks that sulphur dioxide will have a toxic effect on plants. She set up an investigation, over a two-week period, as shown in the diagram below to test her hypothesis. Sodium metabisulphite mixed with water releases sulphur dioxide.

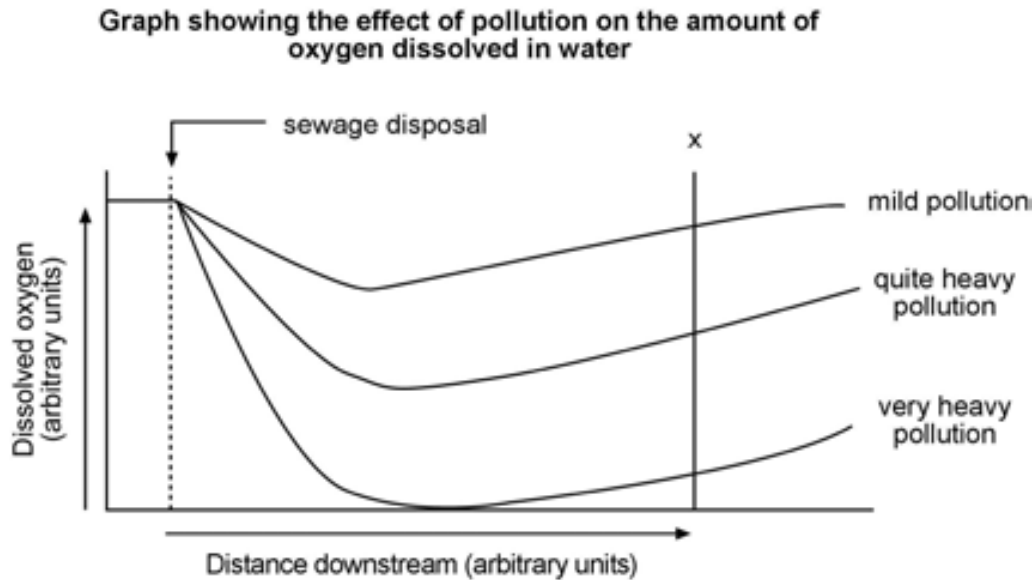


- 1.5.4 In what THREE ways is the experiment a fair test of the hypothesis?
Explain your answer. (6)
- 1.5.5 Suggest TWO ways in which the experimental design could be improved. (4)
[50]

SECTION B

QUESTION 2

- 2.1 The graph below shows the effect of different amounts of sewage discharged into a river, on the amount of dissolved oxygen in the water. Study the graph and answer the questions that follow.



- 2.1.1 Why does the sewage discharge cause oxygen levels to decrease? (2)
- 2.1.2 Why does the minimum amount of oxygen occur some distance downstream of the point of sewage discharge? (2)
- 2.1.3 Why does the level of dissolved oxygen in the river then increase again further downstream? (2)
- 2.1.4 Give TWO possible reasons why sewage would be discharged into river systems in a developing urban environment. (4)
- 2.1.5 Name one positive and one negative effect that “quite heavy pollution” could have on a rural farming community living at point X down the river. (2)

2.2 Birds called thrushes eat snails when their preferred food source, namely insects, are in short supply. To get at the snail, the thrushes break open the shell by hitting the snail against a stone called an anvil. Researchers count the number of shells near an anvil to find out what the thrushes are eating. One particular snail species that the birds eat is *Cepaea nemoralis*. The colour of these shells can be pink, beige, brown, red or yellow, or have dark stripes. Striped shells are described as banded and coloured shells as unbanded. The colour of the shells and the bands provide camouflage for the snails. For example, thrushes cannot see banded shells easily against a “striped” background such as grasses growing on sand dunes. A group of students conducted an investigation of the number of *Cepaea nemoralis* shell remains near anvils. The investigation was carried out in two areas:

area A was in a forest where there were many dead leaves on the ground, i.e. the background was fairly evenly coloured;
 area B was between grasses growing on a sand dune at a beach 50 km away from the forest.

The students put forward the following hypothesis:

“There will be more unbanded than banded shells near anvils in area A (the forest) and there will be more banded than unbanded shells near anvils in area B (grassy sand dunes).”

The results of their investigation in area A are shown in the table below.

Table showing number of *Cepaea nemoralis* shells collected in area A (forest area)

| | Number of snail shells | | | |
|--|------------------------|----------|-------|----------|
| | Banded | Unbanded | Total | % Banded |
| Number of shell remains in forest area | 486 | 377 | 863 | 56.0 |

- 2.2.1 How many more banded than unbanded snail shells were collected? (1)
- 2.2.2 Suggest why the thrushes ate more banded than unbanded snails. (3)
- 2.2.3 Do the results in the table above support the students' hypothesis? Explain your answer. (3)
- 2.2.4 Describe how the students could have worked in the two areas (area A and area B) to ensure that their results were valid. (4)
- 2.2.5 The main points of the theory of evolution by natural selection are listed below:
- The number of offspring produced by an organism is greater than the number that survive to adult stage.
 - Variation exists among the offspring.
 - Some variations are useful and help the organism to survive.
 - Competition occurs between the offspring to ensure survival.
 - Only the survivors can reproduce.

Natural selection can affect the proportions of the different colours of the unbanded shells in a *Cepaea nemoralis* population on sand dunes. Use the five points listed in A–E to explain how such variation may come about.

(7)

[30]

QUESTION 3

3.1 Read through the following text and then answer the questions that follow.

An ever-growing economy, expanding population, rapid increase in visitor numbers and unsustainable consumption patterns are all contributing to Cape Town's significant waste problem.

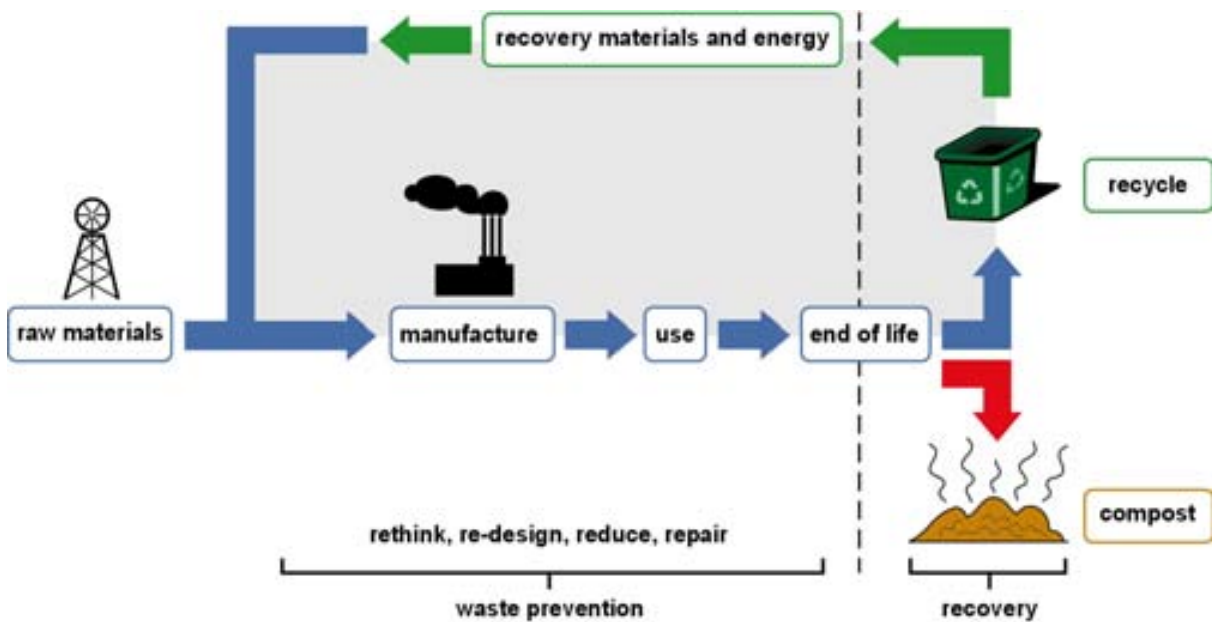
Approximately 6 000 tons of waste are currently generated daily within the City of Cape Town. This is equivalent to covering four soccer fields one metre deep in waste every day. 55% of waste ending up at the Council's six landfill sites is directly received from the industrial and commercial sectors, whereas the domestic waste from households account for approximately 30% of the waste stream. The remaining portion constitutes sewage sludge coming from the city's wastewater treatment plants.

A total of 1.7 million tons of waste was received in landfill sites in Cape Town during 2002, compared to the 1.6 million tons in 2001 and the 1.5 million tons in 2000. This is roughly an annual increase of 7%.

Waste from lower income households are shown to contain about 80% organic waste compared to that from affluent suburbs, which typically contains about 60–70% packaging waste. Of the total amount of waste produced, more than 90% is landfilled by the City of Cape Town.

There is an urgent need for a new regional landfill site as the city faces the closure of most of its current landfill sites. Clean-up costs of litter and dumping exceed R100 million a year. This is money that could be put to far greater use within the city, particularly given the housing crisis.

- 3.1.1. Much of the waste that is deposited on landfills has further uses and many people live on and around these landfill sites to collect these items. List **THREE** possible dangers to the health of the people who live in this environment. (3)
- 3.1.2. Landfills are known to cause pollution of the environment. Briefly describe **TWO** possible ways in which this could happen. (4)
- 3.1.3. Give **ONE** way in which lower income households could reduce the amount of waste that they send to landfills. (1)
- 3.1.4. The flow diagram below illustrates a broad strategy that could be employed to help reduce waste. Discuss how the Cape Town municipality could implement these ideas to reduce the amount of waste sent to the landfills. (7)



3.2 Read the following information about dinosaur extinction.

What caused the mass extinction of the dinosaurs?

Theory A

One theory scientists proposed to explain this mass extinction is based on huge volcanic eruptions which occurred in an area in India (called the Deccan Traps) about 65 million years ago. Some eruptions produced lava flows that released sulphur dioxide into the air, while other eruptions were so powerful that the metal iridium from deep within the Earth reached the surface. These volcanic eruptions spewed ash and other compounds into the atmosphere, causing widespread fires. The ash and dust spread throughout the Earth's atmosphere, blocking the sun's rays for many years. Plants died, the Earth cooled and the dinosaurs became extinct.

Theory B

A second theory, the asteroid impact theory, suggests that a giant asteroid hit the Earth at the end of the Cretaceous era 65 million years ago. The impact caused dust to rise throughout the atmosphere, blocking the sun's rays for many years. Plants died, the Earth cooled and dinosaurs became extinct. The impact of the hot, burning asteroid would have started widespread fires. Evidence for this theory is based on the presence of a layer of the metal iridium, found between two clay layers separating older Cretaceous rocks and younger Tertiary rocks throughout the world (meteors and asteroids contain iridium, which is rare in the Earth's crust). A very large impact crater has been found off the Mexican coast.

3.2.1 Create a flow chart to summarise the theory that volcanic eruptions were responsible for dinosaur extinction. A flow chart is a series of statements separated by arrows.

Begin with the following statement:

Volcanic eruptions released ash and other compounds into the air. (5)

3.2.2 Which theory, A or B, do you think offers a better explanation for the extinction of the dinosaurs? Explain your answer. (5)

3.2.3 Compare and contrast the volcanic eruption theory (A) of mass extinction of the dinosaurs with the present-day Sixth Extinction. (5)

[30]

SECTION C

QUESTION 4

4.1 Study the passage below and answer the questions that follow.

Particle pollution (also called particulate matter or PM) is the term for a mixture of solid particles and liquid droplets found in the air. These particles come in many sizes and shapes and can consist of hundreds of different chemicals. Some particles, known as *primary particles*, are emitted directly from a source such as construction sites, unpaved roads, fields, smokestacks or fires. Others form during complicated reactions in the atmosphere involving chemicals such as sulphur dioxides and nitrogen oxides that are emitted from power plants, industries and automobiles; these particles are known as *secondary particles*.

Particles such as dust, dirt, soot or smoke, are large or dark enough to be seen with the naked eye. Others are so small that they can only be detected using an electron microscope. The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometres (0.01 mm) in diameter pose the greatest problems, because they can penetrate deep into your lungs, and some may reach your bloodstream.

Exposure to such particles can affect both your lungs and your heart. Small particles of concern include those found near roadways and dusty industries – which are between 2.5 micrometres and 10 micrometres in diameter – and those found in smoke and haze, which are smaller than 2.5 micrometres in diameter.

4.1.1 What are the two main forms of particulate matter found in air? (2)

4.1.2 Suggest a reason why small particles are able to not only affect your lungs, but also your heart. (2)

A group of learners performed the following simple experiment to measure the presence of particulate matter (PM) in air in their town.

- A. Three areas of 1cm² were drawn on five glass microscope slides, using a permanent marking pen.
- B. The other side of each slide was then covered by a thin layer of petroleum jelly.
- C. The slides were then placed, with the side covered with petroleum jelly facing up, in five different outdoor locations throughout the town and left for one week.
- D. The slides were collected after a week and examined using a hand lens (magnification = x20). The visible particles in each square were counted and recorded in a data table.
- E. The average number of visible particles per square for each of the locations was then calculated and presented on a graph.

4.1.3 What was the aim of the experiment? (2)

4.1.4 Was this a fair test? Explain your answer. (4)

The five slides were placed at the following locations:

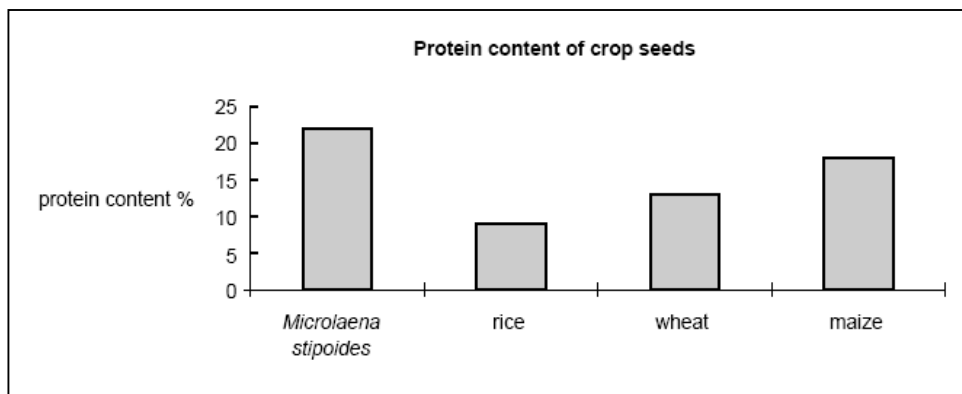
- 1) traffic lights in the CBD of town
- 2) town sports fields
- 3) the construction site for a new shopping centre
- 4) the industrial area of the town
- 5) a fishing spot on the outskirts of the town.

4.1.5 Which slide do you believe would have the highest average number of visible particles per 1 cm² block? Give a reason for your answer, based on the information given above. (3)

4.1.6 Which slide do you believe would have the lowest average number of visible particles per 1 cm² block? Give a reason for your answer, based on the information given above. (3)

4.2 In Australia, like in South Africa, large areas of the country receive particularly little rainfall. Australian agricultural biologists are currently researching weeping rice grass (*Microlaena stipoides*), a deep-rooted native relative of rice. Their aim is to produce drought-tolerant grain crops, pasture grass for livestock and domestic lawns.

M. stipoides thrives in a variety of soil types, from coastal to mountain habitats. It does not spread in an uncontrolled way as many introduced grasses do. It requires less fertiliser and liming of soil than introduced crop species.



At present *M. stipoides* seed is only half the size of domestic rice. A researcher stated that weeping rice grass has not undergone selection or breeding for larger seed size.

4.2.1 Why does low rainfall present a problem to farmers in South Africa and Australia? (1)

4.2.2 *M. stipoides* is indigenous to Australia. What possible advantages are there for South African farmers ultimately being able to use this plant in agriculture, rather than the regular “alien” crops that are currently used? (3)

- 4.2.3 Give THREE reasons why it is now more important than ever that scientists globally are researching the uses of various alternative plant species as food sources. (3)
- 4.2.4 What might be the advantage of breeding this species for larger seed size? (1)
- 4.2.5 There may be negative effects associated with selective breeding. Outline ONE risk associated with this type of breeding. (1)
- 4.3 Read the passages (A–D) regarding mining of the titanium-rich dunes in the Xolobeni area of Pondoland along the Eastern Cape coast. Do you think the dunes should be mined? Use the information from the passages to assist you in making a decision. Your written response should be 1 to 1½ pages long and must be supported by evidence from the source material.

SOURCE A: The area for which dune mining is proposed

The proposed dune-mining site in the Xolobeni area, about halfway between East London and Durban, is under threat. The area includes several rivers and estuaries. Many homes are situated close to the site and it is not yet clear whether people will be forced to move.

Residents don't believe promises that they will not be forced to relocate. "Our forefathers lived in this area and we farm here," said Mthanjelwa Mpotomela. He said even if people were not forced to relocate, they would have to leave because tremors from the mine would threaten the safety of their mud houses.

SOURCE B: Mining and rehabilitating dunes

Dredge mining, as proposed for Pondoland dunes, extracts heavy minerals from the dunes after removing all existing vegetation. Afterwards dunes are reshaped and covered with topsoil seeded with cereal seeds, which germinate and grow rapidly, and seeds of indigenous long-living (woody) species.

During early rehabilitation *Acacia karroo* dominate, but species richness progressively increases. Woody species later become more abundant, with *A. karroo* being less dominant.

Soil quality in rehabilitated areas compare favourably to that of pre-mined areas, suggesting that nutrients are retained and contribute to the re-establishment of plant and animal colonies. This provides evidence of sustainable soil..

SOURCE C: Predicted benefits for the community

The mining company that won the mining rights has formed a partnership with a local community group to create economic upliftment for the people of Xolobeni.

Most of the community are unemployed, many people are illiterate and children have to walk far

to get to school. Malnutrition is common and many people live far from clinics. Few houses have electricity or running water, and water has to be collected from rivers.

The mining company intends to invest in the local communities through, for example, creating basic infrastructure. Proposed road infrastructure will contribute to economic development in the area.

SOURCE D: The conservationist's point of view

Conservationists and tourism authorities oppose the building of a road in the Pondoland area, saying it will pass through a sparsely populated area and thereby threaten other communities' existing ecotourism activities.

Many plants that grow here are found nowhere else in the world. Preserving the area as an ecotourism destination will bring widespread and lasting benefits, they argue.

A complaint submitted to the Human Rights Commission on behalf of the local communities, state that their right to relevant information for exercising or protecting their rights, and the right to environmental protection for present and future generations' benefit are being violated.

NOTE: NO marks will be awarded for answers in the form of diagrams.

(15)

[40]

GRAND TOTAL: 150