Materials
For this paper you must have:
• Ruler
• Pencil, Rubber, Protractor and Compass
• Scientific calculator, which you are expected to use when appropriate

Instructions
• Answer all questions
• Answer questions in the space provided
• All working must be shown
• Do all rough work in this book. Cross out any rough work you don’t want to be marked

Information
• The marks for the questions are shown in brackets
The diagram below shows a food web.

(a) What name is given to all the organisms together in an ecosystem?

Tick one box.

Community

Environment

Habitat

Population

(b) Give the name of one secondary consumer shown in the diagram above.

(1)
Algae can photosynthesise.

(c) Which word describes the algae in this food web?

Tick one box.

- Consumer
- Predator
- Prey
- Producer

(1)

(d) Explain why most algae are found near the surface of the sea, and not at greater depths.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(e) Toothed whales will compete with each other for food.

Suggest what else toothed whales might compete for.

___________________________________________________________________
___________________________________________________________________

(1)
(f) Look at the diagram above.

The population of leopard seals decreases if there are fewer elephant seals.

Explain why.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
(Total 8 marks)

A class of eight students measured the population of water fleas living at the edge of a large pond.

This is the method each student used.

1. Put some pond water in a white tray.
2. Take a pond net and scoop at the edge of the pond a few times.
3. Empty the pond net into the water in the tray.
4. Count the number of water fleas in the tray.

The photograph below shows a student working.
(a) The students did **not** control some variables.

Give **two** variables the students should have controlled to make this a valid method.

1. _________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

2. _________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

(2)

The eight students then used a different method to obtain valid results.

**Table 1** shows their results.

<table>
<thead>
<tr>
<th>Student</th>
<th>Number of water fleas per 1000 cm³ pond water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>37</td>
</tr>
<tr>
<td>C</td>
<td>51</td>
</tr>
<tr>
<td>D</td>
<td>102</td>
</tr>
<tr>
<td>E</td>
<td>40</td>
</tr>
<tr>
<td>F</td>
<td>122</td>
</tr>
<tr>
<td>G</td>
<td>75</td>
</tr>
<tr>
<td>H</td>
<td>19</td>
</tr>
</tbody>
</table>

(b) Calculate the students’ mean value for the population of water fleas at the edge of the pond.

Mean population = ______________________ water fleas per 1000 cm³ pond water

(1)

(c) What was the range of the students’ results?

Range = ______________________

(1)
(d) Suggest one reason why such a wide range of results was found.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(e) The teacher then sampled the centre of the pond eight times.
His mean value was 12 water fleas per 1000 cm$^3$ pond water.
What conclusion can you make about the distribution of water fleas in the pond?
Use the students’ mean value from part (b) to compare with the teacher’s mean value.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1)

Scientists counted some different invertebrates living in a pond in 2014 and in 2016
**Table 2** shows the results.

<table>
<thead>
<tr>
<th>Invertebrate species</th>
<th>Number of invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
</tr>
<tr>
<td>Bloodworms</td>
<td>13</td>
</tr>
<tr>
<td>Freshwater shrimps</td>
<td>24</td>
</tr>
<tr>
<td>Mayfly nymphs</td>
<td>32</td>
</tr>
<tr>
<td>Water snails</td>
<td>19</td>
</tr>
</tbody>
</table>

(f) Calculate the change in the number of bloodworms between 2014 and 2016
___________________________________________________________________
Change = _______________________ bloodworms

(1)

(g) Calculate the number of shrimps in the pond in 2016 as a percentage of the number of shrimps in the pond in 2014
___________________________________________________________________
Percentage = _______________________ %

(1)
(h) Invertebrate species found in a pond can be used as an indicator of the pollution level.

**Table 3** shows which species can survive in different levels of pollution.

<table>
<thead>
<tr>
<th>Invertebrate species</th>
<th>Pollution level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Bloodworms</td>
<td>✓</td>
</tr>
<tr>
<td>Freshwater shrimps</td>
<td>✓</td>
</tr>
<tr>
<td>Mayfly nymphs</td>
<td>✓</td>
</tr>
<tr>
<td>Water snails</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Key**
- ✓ = Can survive
- ✘ = Cannot survive

What conclusion can you make about the change in the level of pollution in the pond between 2014 and 2016?

Give one reason for your conclusion.

Use the data in **Table 2** and **Table 3**

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(i) Water pollution and global warming are two problems that have been caused by the rapid increase of the human population.

Suggest two other problems caused by the rapid increase of the human population.

1. _________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________

2. _________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________

(Total 12 marks)
In 2017, the city of Manchester began a ‘City of Trees’ project.

The city council intend to plant 3 million trees over the next 25 years.

The trees will be planted:
- to make woodlands larger
- to make new woodlands
- in parks, streets and in people’s gardens.

(a) How will the trees benefit the people living in Manchester?

Tick two boxes.

- By dropping leaves on the streets in autumn.
- By hiding the road signs.
- By helping people relax in outdoor spaces
- By putting soot in the air.
- By reducing the noise pollution.

(b) How will the trees benefit the environment in Manchester?

Tick two boxes.

- By giving more space for car parks.
- By hiding old buildings.
- By making new habitats for plants and animals.
- By providing a resting place for migrating birds.
- By taking more oxygen out of the air.
It was suggested that 360 000 trees should be planted in the first year.

(c) How many trees would still need to be planted in the remaining 24 years?

___________________________________________________________________

Number of trees = ____________________

(1)

(d) If the council planted an equal number of trees in each remaining year how many would they plant each year?

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

Number of trees per year = ____________________

(2)

The council says that planting new trees will increase biodiversity in the area.

(e) What is the definition of biodiversity?

Tick one box.

The arrival of new predators in an ecosystem. [ ]

The evolution of new species by natural selection. [ ]

The recycling of carbon in the environment. [ ]

The variety of different species of organisms in an ecosystem. [ ]

(1)

(f) Suggest one other way the council could increase biodiversity in Manchester.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(1)

(Total 9 marks)
This question is about ecology.

(a) Give two abiotic (non-living) factors which will affect the growth of plants on a school playing field.

Give a reason why each factor will affect the growth of the plants.

Abiotic factor 1 ______________________________________________________
Reason ____________________________________________________________
___________________________________________________________________

Abiotic factor 2 ______________________________________________________
Reason ____________________________________________________________
___________________________________________________________________


Students were studying the ecology of their playing field.

They wanted to count the population of ruby tiger moths.

**Figure 1** shows the moth trap they used.

**Figure 1**

- UV light bulb to attract moths at night
- Plastic funnel for moths to crawl down
- Plastic outer case of moth trap
- Cardboard egg trays for moths to settle on

This is the method used.

1. Set up the moth trap on the playing field.
2. Leave the trap for several days with the light on.
3. Take the trap to the laboratory and carefully remove the egg trays.
4. Count the number of ruby tiger moths.
5. Release the moths on the playing field.
(b) The students needed other equipment to identify the ruby tiger moths.

What two other pieces of equipment did the students need?

Tick two boxes.

Electron microscope  
Hand lens  
Moth guide  
Quadrat  
Tape measure

(2)

(c) Suggest one reason why the moths were counted in the laboratory.

___________________________________________________________________

(1)

(d) Suggest one hazard in using the moth trap.

___________________________________________________________________

(1)

(e) What precaution should the students take to minimise the hazard you suggested in part (d)?

___________________________________________________________________

(1)
Figure 2 shows a caterpillar of the ruby tiger moth.

The head is sometimes bright orange in colour or there is a red stripe on the back.

Figure 2

(f) Give one reason why caterpillars of the ruby tiger moth have very few predators.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1) (Total 10 marks)
Some animals are adapted to survive in very cold conditions such as the Arctic.

Explain how the adaptations of Arctic animals help them to survive in cold conditions.

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_______________________________________________________________________

(Total 6 marks)
Moose are animals that eat grass.

**Figure 1** shows a moose.

![Figure 1](https://www.wildnerdpix/iStock/Thinkstock)

**Figure 2** shows a food chain.

**Figure 2**

Grass → Moose → Wolves

(a) Name the secondary consumer shown in **Figure 2**.

___________________________________________________________________

(1)
(b) **Figure 3** shows how the moose population and wolf population have changed in one area.

This is a predator-prey cycle.

**Figure 3**

![Graph showing moose and wolf population over years](image)

In 2004 the line on **Figure 3** for wolves is above the line for moose.

How does **Figure 3** show that there are more moose than wolves in 2004?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(1)

(c) Suggest why the moose population decreased between 2002 and 2004.

Use information from **Figure 3**.

___________________________________________________________________
___________________________________________________________________

(1)

(d) The number of wolves is one biotic factor that could affect the size of the moose population.

Give two other biotic factors that could affect the size of the moose population.

1. ___________________________________________________________________
   ___________________________________________________________________

2. ___________________________________________________________________
   ___________________________________________________________________

(2)
(e) Moose have distinct characteristics such as antlers.

Describe how moose may have evolved to have large antlers.

___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Many biotic and abiotic factors can affect the growth of plants.

(a) Are the factors in Table 1 biotic or abiotic?

Tick one box for each factor.

Table 1

<table>
<thead>
<tr>
<th>Factor</th>
<th>Biotic</th>
<th>Abiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbivores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Two students investigated the effect of light intensity on the distribution of small plants.

The plants are growing under a tree in a park.

The students made the following hypothesis:

‘As you move outwards from a tree there will be more plant growth.’
(b) Explain why the students thought their hypothesis would be correct.

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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________

(3)

(c) The students used two pieces of equipment.

Give the scientific name of each piece of equipment.

A square frame measuring 0.5 m × 0.5 m  ____________________________
An electronic device to measure light intensity  ____________________________

(2)

This is the method used.

1. Fix one end of a tape measure at the base of the tree.
2. Fix the other end of the tape measure 11 metres from the tree.
3. At 0 metres put the square frame on the ground.
4. Identify all the plant species growing inside the frame.
5. Estimate and record the percentage cover of each plant species.
6. Measure the light intensity inside the frame.
7. Put the square frame on the ground every 2 metres along the tape to 10 metres.
8. Repeat steps 4 − 6 in every frame.

The diagram below shows the equipment in this investigation.
(d) Calculate the total area sampled.

___________________________________________________________________
___________________________________________________________________

Total area sampled = ______________________ m²

(1)

(e) The whole investigation was done as quickly as possible on the same day.

Suggest one reason why.

___________________________________________________________________
___________________________________________________________________

(1)

(f) Give one way the investigation could be improved.

___________________________________________________________________
___________________________________________________________________

(1)

Table 2 shows the results.

Table 2

<table>
<thead>
<tr>
<th>Distance from tree in metres</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage cover of grass</td>
<td>15</td>
<td>50</td>
<td>35</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Percentage cover of plantain</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>40</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Percentage cover of daisy</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Percentage cover of clover</td>
<td>1</td>
<td>10</td>
<td>25</td>
<td>40</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td><strong>Total percentage cover of plants</strong></td>
<td>16</td>
<td>65</td>
<td>70</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Light intensity in arbitrary units</td>
<td>37</td>
<td>59</td>
<td>150</td>
<td>175</td>
<td>&gt;200</td>
<td>&gt;200</td>
</tr>
</tbody>
</table>

(g) Which plant species in Table 2 will only grow at high light intensity?

___________________________________________________________________

(1)
(h) What conclusion can be made about the relationship between light intensity and the total percentage cover of plants?

Use data from Table 2 in your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(i) Light intensity might not be the cause of this pattern of plant distribution.

Suggest one different factor that may cause these results.

Give one reason for your answer.

Factor _____________________________________________________________
Reason _____________________________________________________________
___________________________________________________________________

(2)

(Total 15 marks)

Figure 1 shows a rocky shore.

Figure 1

Stony beach  Sand  Large shallow rock pool  Edge of the sea  Sea

Students were asked to investigate how the abundance and distribution of different organisms change as you move from the edge of the sea to the stony beach.
(a) Describe a method the students could use.
(b) A kite diagram shows the distribution and number of organisms.

Figure 2 shows a kite diagram of the results from a similar investigation on the same rocky shore.

Figure 2

![Kite Diagram of Organisms]

<table>
<thead>
<tr>
<th>Organism</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder wrack</td>
<td></td>
</tr>
<tr>
<td>Sand worm</td>
<td></td>
</tr>
<tr>
<td>Toothed wrack</td>
<td></td>
</tr>
<tr>
<td>Periwinkle</td>
<td></td>
</tr>
<tr>
<td>Red algae</td>
<td></td>
</tr>
<tr>
<td>Common limpet</td>
<td></td>
</tr>
<tr>
<td>Dog whelk</td>
<td></td>
</tr>
</tbody>
</table>

No samples taken in sea

Key

- The deeper the kite, the more organisms are found
- Distribution: where the organisms are found

Which organism was most abundant?

Give a reason for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
(c) The shallow rock pool in Figure 2 has a **higher biodiversity** than the sand or the stony beach.

Suggest **three** reasons why.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)  
(Total 11 marks)

In 2017, the city of Manchester began a ‘City of Trees’ project.

The project plans to plant 3 million trees over the next 25 years.

The trees will be used to:

• make existing woodlands larger
• link existing woodlands
• create new woodlands
• plant in parks, public gardens and along streets
• give to people to plant in private gardens.

(a) It was suggested that the council plant $3.6 \times 10^5$ trees in the first year.

The rest of the trees would be planted in equal numbers over the remaining years.

Calculate how many trees would need to be planted in each of the remaining years.

Give your answer in standard form.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Number of trees = ____________________ per year

(3)
Students investigated the number of bluebells in one of the existing woodlands.

The diagram shows the dimensions of the woodland.

The students used a 0.25 m\(^2\) quadrat to sample the bluebell population.

The mean number of bluebells per quadrat was 6

Estimate the population of bluebells in the woodland.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Population = ____________________ bluebells (2)
A Manchester resident says that this project will ‘fight pollution’ and ‘increase biodiversity’ in their city.

Explain how the ‘City of Trees’ project will:
• reduce pollution
• increase biodiversity.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(6)
(Total 11 marks)
Owls are predators of mice and voles.

(a) Which of the following are biotic factors that would affect owl populations?

Tick two boxes.

- Availability of food
- Carbon dioxide levels
- Moisture levels
- New diseases
- Oxygen levels
- Soil pH

Scientists collected population data for mice, voles and owls from one woodland over two years.

(b) The scientists collected the data using sampling techniques.

Suggest why the population data collected may not be accurate.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
The graph below shows how the total number of mice and voles changed over two years.

(c) The number of owls also changed over the same time period.

The changes in the numbers followed a typical predator–prey relationship.

Sketch a line on the graph above to show how you would expect the number of owls to change.

(d) What would happen to the number of voles if the population of mice decreased?

Give reasons for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 9 marks)