Materials
For this paper you must have:

- Ruler
- Pencil and Rubber
- 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

Information
- The marks for the questions are shown in brackets
A student was asked to estimate how many clover plants there are in the school field.

The image below shows the equipment used.

This is the method used.

1. Throw a quadrat over your shoulder.
2. Count the number of clover plants inside the quadrat.
3. Repeat step 1 and step 2 four more times.
4. Estimate the number of clover plants in the whole field.

(a) What is the tape in the image above used for in this investigation?

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(1)

(b) The teacher told the student that throwing the quadrat over his shoulder was not random.

The method could be improved to make sure the quadrats were placed randomly.

Suggest one change the student could make to ensure the quadrats were placed randomly.

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(1)
(c) How could the student improve the investigation so that a valid estimate can be made?

Tick **two** boxes.

- Weigh the clover plants
- Compare their results with another student’s results
- Count the leaves of the clover plants
- Place more quadrats
- Place the quadrats in a line across the field

(2)
(d) The table below shows the student’s results.

<table>
<thead>
<tr>
<th>Quadrat number</th>
<th>Number of clover plants counted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

The area of the school field was 500 m².

The quadrat used in the table above had an area of 0.25 m².

Calculate the estimated number of clover plants in the school field.

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Estimated number of clover plants = .................................

(3)
(e) What was the mode for the results in the table above?

Tick **one** box.

- 1
- 8
- 11
- 40

(Total 9 marks)

(f) Suggest which quadrat could have been placed under the shade of a large tree.

Give **one** reason for your answer.

Quadrat number ..........................

Reason ........................................................................................................................................
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(Total 9 marks)
Malaria is a disease caused by a microorganism carried by mosquitoes. The microorganism is transferred to humans when adult female mosquitoes feed on human blood.

The figure below shows the life cycle of a mosquito.

The World Health Organisation estimates that $3 \times 10^8$ people are infected with malaria every year.

Scientists estimate that malaria kills $2 \times 10^6$ people every year.

The people who are infected with malaria but do not die, may be seriously ill and need health care for the rest of their lives.

(a) Based on the estimated figures, what percentage of people infected with malaria die from the disease?
(b) An internet article states:
1 Mosquito larvae are at the start of the food chain for some fish.
2 Adult mosquitoes provide food for bats and birds.
3 Mosquitoes are also important in plant reproduction because they feed from flowers of crop plants.

(i) The first sentence in the article is not correct.

Explain why.

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(2)

(ii) A company plans to produce genetically modified (GM) adult male mosquitoes. The GM mosquitoes will carry a gene from bacteria. The gene causes the death of offspring before they become adults.

Male mosquitoes do not feed on blood.
Scientists are considering releasing millions of adult male GM mosquitoes into the wild.

Do you think scientists should release millions of male GM mosquitoes into the wild?
In your answer you should give advantages and disadvantages of releasing GM mosquitoes into the wild.

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(4)
Ragwort is a plant that often grows as a weed in grassland.

The image below shows a ragwort plant.

© Difydave/iStock

Some students estimated the number of ragwort plants growing in a field on a farm.

The students:
• placed a quadrat at 10 random positions in the field
• counted the number of ragwort plants in each quadrat.

The quadrat measured 1 metre × 1 metre. The area of the field was 80 000 m².
The table below shows the students' results.

<table>
<thead>
<tr>
<th>Quadrat number</th>
<th>Number of ragwort plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

(a) Complete the following calculation to estimate the number of ragwort plants in the field.

Use information from the table above.

Total number of ragwort plants in 10 quadrats = ..........................................

Mean number of ragwort plants in 1 m² = ..........................................................

Therefore estimated number of ragwort plants in field = ..................................

(2)

(b) What could the students do to get a more accurate estimate?

Tick (✔) one box.

- Place the quadrat in 100 random positions.
- Place the quadrat only in areas where they could see ragwort plants.
- Place the quadrat in positions at the edge of the field.

(1)
The farmer who owned the field kept horses.

If horses eat ragwort, the ragwort can poison them.

The farmer considered two methods of controlling ragwort in his field.

**Method 1:** Spraying with a selective weed killer

**Method 2:** Pulling out the ragwort plants by hand

In **Method 1:**

- the cost of the weed killer was £420
- the weed killer would not harm the grass but would kill all other plants
- the farmer could apply the weed killer from a sprayer towed by a tractor.

**Method 2** could be done by local volunteers.

What are the advantages and disadvantages of using **Method 2** instead of **Method 1** for controlling ragwort?

**Advantages of **Method 2** ...............................................................**

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**Disadvantages of **Method 2** ...............................................................**

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4

Some students wanted to estimate the number of plantain plants in a grassy field.

The field measured 100 metres × 50 metres.

The students:

- chose areas where plantains were growing
- placed 10 quadrats in these areas
- counted the number of plantains in each of the 10 quadrats.

Each quadrat measured 25 cm × 25 cm.
The table below shows the students' results.

<table>
<thead>
<tr>
<th>Quadrat number</th>
<th>Number of plantain plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>2</td>
<td>1</td>
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<tr>
<td>3</td>
<td>4</td>
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<td>4</td>
<td>1</td>
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<td>5</td>
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<tr>
<td>6</td>
<td>2</td>
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<td>7</td>
<td>4</td>
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<tr>
<td>8</td>
<td>1</td>
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<tr>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

(a) Complete the following calculation to estimate the number of plantain plants in the field.

Use the students' results from the table above.

Total number of plantains in 10 quadrats = ........................................................

Total area of 10 quadrats = ............................................................................... m$^2$

Mean number of plantains per m$^2$ = .................................................................

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Area of field = .................................................................................................... m$^2$

Therefore estimated number of plantains in field = ............................................

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(3)
The students’ method would **not** give a valid estimate of the number of plantain plants in the field.

Describe **three** improvements you could make to the students’ method.

For each improvement, give the reason why your method would produce more valid results than the students’ method.

Improvement 1 ...........................................................................................................

Reason ....................................................................................................................

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Improvement 2 ....................................................................................................

Reason ....................................................................................................................

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Improvement 3 ....................................................................................................

Reason ....................................................................................................................

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(3)

(Total 6 marks)
A grassy field on a farm measured 120 metres by 80 metres.

A student wanted to estimate the number of buttercup plants growing in the field.

The student found an area where buttercup plants were growing and placed a 1 m × 1 m quadrat in one position in that area.

Figure 1 shows the buttercup plants in the quadrat.

The student said, ‘This result shows that there are 115 200 buttercup plants in the field.’

(a) (i) How did the student calculate that there were 115 200 buttercup plants in the field?
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(ii) The student’s estimate of the number of buttercup plants in the field is probably not accurate. This is because the buttercup plants are not distributed evenly.

How would you improve the student’s method to give a more accurate estimate?
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(b) Sunlight is one environmental factor that might affect the distribution of the buttercup plants.

(i) Give three other environmental factors that might affect the distribution of the buttercup plants.

1. ........................................................................................................................................

2. ........................................................................................................................................

3. ........................................................................................................................................

(3)

(ii) Explain how the amount of sunlight could affect the distribution of the buttercup plants.

(3)
Every year, the farmer puts fertiliser containing mineral ions on some of his fields. When there is a lot of rain, some of the fertiliser is washed into the river.

(i) When fertiliser goes into the river, the concentration of oxygen dissolved in the water decreases.

Explain why the concentration of oxygen decreases.

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(ii) There is a city 4 km downstream from the farm.

Apart from fertiliser, give one other form of pollution that might go into the river as it flows through the city.
(d) Three sites, A, B and C, are shown in Figure 2.

Scientists took many samples of river water from these sites.

The scientists found larvae of three types of insect in the water: mayfly, stonefly and caddisfly. For each type of insect the scientists found several different species.

The scientists counted the number of different species of the larvae of each of the three types of insect.

Figure 3 shows the scientists’ results.

(i) How many more species of mayfly were there at Site B than at Site A?

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(ii) Suggest what caused this increase in the number of species of mayfly.

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(iii) The scientists stated that the number of species of stonefly was the best indicator of the amount of oxygen dissolved in the water.

Use information from Figure 3 to suggest why.

(Total 19 marks)
Organisms compete with each other.

(a) **Figure 1** shows two types of seaweed which live in similar seashore habitats.

![Figure 1](image)

Most of the time the two seaweeds are covered with water.

Bladder wrack has bladders filled with air.

Bladder wrack grows more quickly than saw wrack. Suggest an explanation why.

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(3)
(b) **Figure 2** shows an angler fish.

![Figure 2](https://www.examqa.com/image.png)

Angler fish live at depths of over 1000 m.

In clear water, sunlight does not usually reach more than 100 m deep. Many angler fish have a transparent ‘lure’ containing a high concentration of bioluminescent bacteria.

Bioluminescent bacteria produce light.

Suggest an advantage to the angler fish of having a lure containing bioluminescent bacteria.

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(2)
(Total 5 marks)
In January 2011 more than 600 000 people collected results for the UK national bird survey. People recorded the number of each species of bird they saw in 1 hour on 1 day in their garden.

Some of the results are shown in the table below.

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean number of birds seen per garden</th>
<th>Percentage of gardens in which the bird was seen</th>
</tr>
</thead>
<tbody>
<tr>
<td>House sparrow</td>
<td>4.1</td>
<td>64.5</td>
</tr>
<tr>
<td>Starling</td>
<td>3.9</td>
<td>51.3</td>
</tr>
<tr>
<td>Blackbird</td>
<td>3.2</td>
<td>95.2</td>
</tr>
<tr>
<td>Goldfinch</td>
<td>1.5</td>
<td>33.5</td>
</tr>
</tbody>
</table>

(a) A student looked at the table and said:

“In the UK, house sparrows are more common than blackbirds.”

Suggest three reasons why the student’s statement may not be true.

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(3)
(b) A survey in 2012 was done in the same way as the 2011 survey.

The graph below shows changes in the percentages of gardens in which some birds were seen from 2011 to 2012.

(i) Calculate the percentage of gardens in which goldfinches were seen in 2012.

Use information from the graph and the table.

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Answer = ................................ %

(ii) Suggest two reasons why goldfinches were seen in more gardens in 2012 than in 2011.

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(2)

(Total 7 marks)