

Answer BOTH questions.

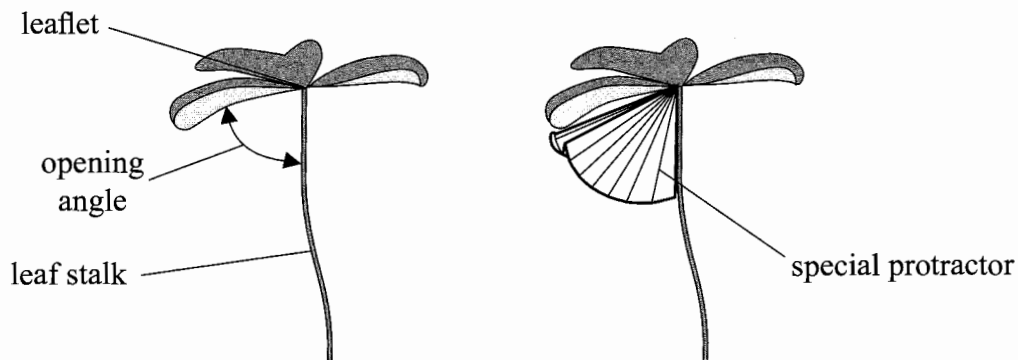
Write your answers in the spaces provided.

1. Wood sorrel is a common plant of woodland. Its leaves respond to decreasing light intensity by showing 'sleep' movements, in which leaflets fold towards the leaf stalk. Increasing light intensity causes these movements to be reversed.

A student investigated these movements by using plants from two different woodland habitats, one that was more shaded than the other.

He took ten samples from each of these habitats and placed their leaf stalk in tubes containing water. These were left in the dark until the leaflets were fully folded towards the stalk. He then exposed the samples to the same light intensity for twenty minutes.

After this time he measured the angle between the stalk and one of the leaflets for each of the twenty samples using a special protractor as shown in the diagram below. The opening angle was recorded in degrees and minutes. One degree is divided into 60 minutes.



diagrams by permission of Fumi Naganishi, Tokyo Gakugei University



A copy of the student's notebook, with the opening angles of wood sorrel from the two habitats, is shown below.

Lightly shaded woodland - Opening angle

70 degrees 45 minutes 65 degrees 20 minutes 68 degrees 30 minutes
52 degrees 00 minutes 72 degrees 15 minutes 66 degrees 30 minutes
71 degrees 45 minutes 66 degrees 40 minutes 75 degrees 10 minutes
58 degrees 15 minutes

Heavily shaded woodland - Opening angle

75 degrees 45 minutes 80 degrees 30 minutes 68 degrees 10 minutes
82 degrees 20 minutes 69 degrees 15 minutes 74 degrees 00 minutes
79 degrees 00 minutes 78 degrees 30 minutes 81 degrees 45 minutes
73 degrees 20 minutes

N.B. One degree is divided into 60 minutes

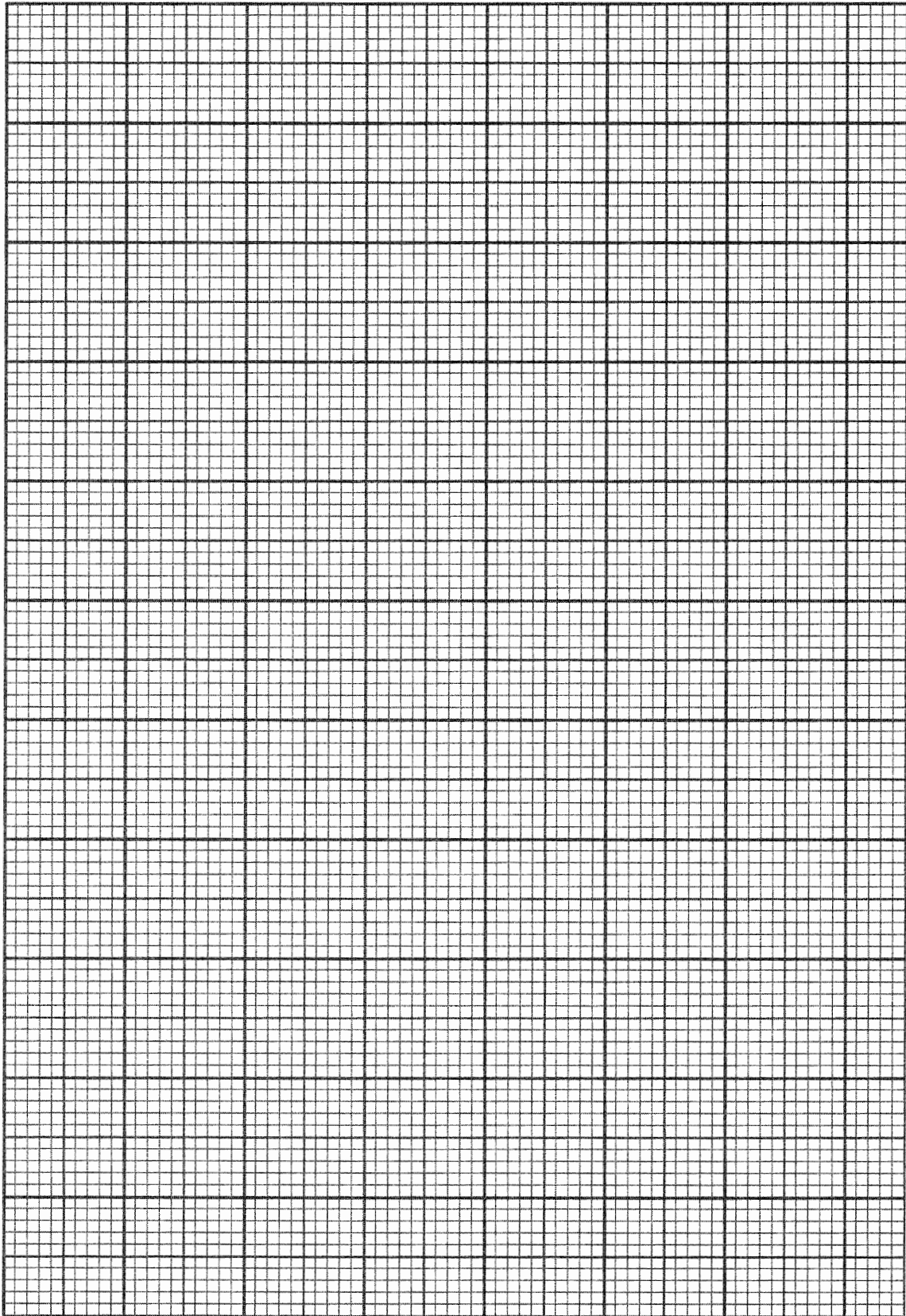


- (a) Calculate the opening angles in decimal format (e.g. $70^{\circ} 45 \text{ mins} = 70.75^{\circ}$) and prepare a table to show these angles, together with the mean opening angle of leaflets, for each of the two habitats.

(3)



(b) Use the information in your table to present the data in a suitable graphical form.



(2)



(c) State a suitable null hypothesis for this investigation.

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(1)

(d) A *t*-test was applied to these data to determine whether the means of each group were significantly different.

A *t*-value of 3.62 was calculated.

The table below shows critical values for *t* with 18 degrees of freedom for various levels of significance.

Significance level (%)	20	10	5	2	1
Critical value of <i>t</i>	1.33	1.73	2.10	2.55	2.88

What conclusion can be drawn from this investigation? Use the information provided in the table to explain your answer.

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(2)



(e) Describe **three** limitations of this method that could affect the reliability of the results.

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(3)

(Total 11 marks)

Q1

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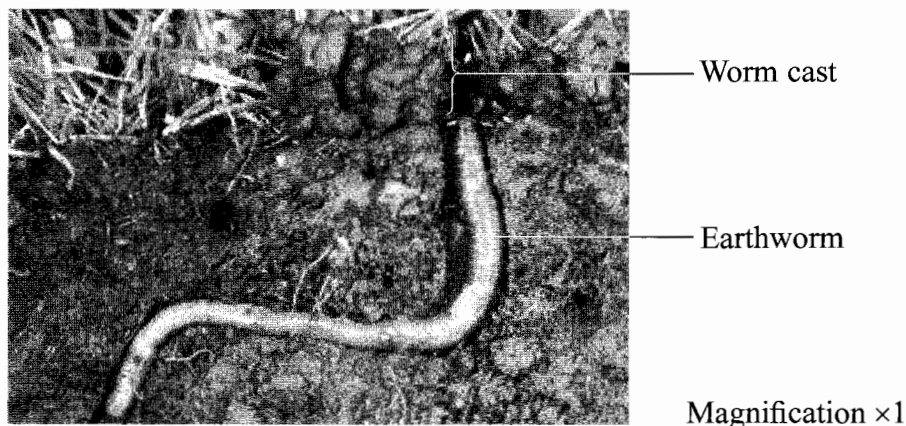
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2. Earthworms are animals important in maintaining soil quality. If their numbers fall, soil aeration and water penetration may be severely reduced.

Farmers usually prepare ground for growing crops by turning over the soil using a 'traditional' plough, but earthworm numbers fall when such a method is used. A farmer decided to try out a new technique using a 'chisel' plough, where the soil is not turned over.

Some species of earthworms produce faeces in the form of 'casts' on the surface of the soil and the mass of casts in an area can be used to assess the number of earthworms present.



Design an investigation the farmer can use to test the hypothesis that there are more earthworms found in soil subjected to 'chisel' ploughing compared with soil subjected to 'traditional' ploughing. Your suggested study should have little impact on the environment and the earthworms.

Your answer should give details under the following headings.

(a) Plan of the investigation to be carried out.

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(10)



N 3 1 0 5 1 A 0 1 1 1 6

(b) Recording of raw data measurements, presentation of results and data analysis.

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