



1. A mobile library has 160 books for children on its records. The librarian believes that books with fewer pages are borrowed more often. He takes a random sample of 10 books for children.

(a) Explain how the librarian should select this random sample. (2)

The librarian ranked the 10 books according to how often they had been borrowed, with 1 for the book borrowed the most and 10 for the book borrowed the least. He also recorded the number of pages in each book. The results are in the table below.

| Book            | A  | B   | C   | D  | E   | F  | G   | H   | I   | J   |
|-----------------|----|-----|-----|----|-----|----|-----|-----|-----|-----|
| Borrowing rank  | 1  | 2   | 3   | 4  | 5   | 6  | 7   | 8   | 9   | 10  |
| Number of pages | 50 | 212 | 115 | 80 | 301 | 90 | 356 | 283 | 152 | 317 |

(b) Calculate Spearman’s rank correlation coefficient for these data. (4)

(c) Test the librarian’s belief using a 5% level of significance. State your hypotheses clearly. (3)

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2. A researcher believes that the mean weight loss of those people using a slimming plan as part of a group is more than 1.5 kg a year greater than the mean weight loss of those using the plan on their own. The mean weight loss of a random sample of 80 people using the plan as part of a group is 8.7 kg with a standard deviation of 2.1 kg. The mean weight loss of a random sample of 65 people using the plan on their own is 6.6 kg with a standard deviation of 1.4 kg.

(a) Stating your hypotheses clearly, test the researcher’s claim. Use a 1% level of significance.

**(8)**

(b) For the test in part (a), state whether or not it is necessary to assume that the weight loss of a person using this plan has a normal distribution. Give a reason for your answer.

**(2)**

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3. A nursery has 16 staff and 40 children on its records. In preparation for an outing the manager needs an estimate of the mean weight of the people on its records and decides to take a stratified sample of size 14.

(a) Describe how this stratified sample should be taken. (3)

The weights,  $x$  kg, of each of the 14 people selected are summarised as

$$\sum x = 437 \text{ and } \sum x^2 = 26983$$

(b) Find unbiased estimates of the mean and the variance of the weights of all the people on the nursery's records. (4)

(c) Estimate the standard error of the mean. (2)

The estimates of the standard error of the mean for the staff and for the children are 5.11 and 1.10 respectively.

(d) Comment on these values with reference to your answer to part (c) and give a reason for any differences. (2)

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**Question 4 continued**

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**Q4**

**(Total 9 marks)**



5. (i) The volume,  $B$  ml, in a bottle of *Burxton's* water has a normal distribution  $B \sim N(325, 6^2)$  and the volume,  $H$  ml, in a bottle of *Hargate's* water has a normal distribution  $H \sim N(330, 4^2)$ .

Rebecca buys 5 bottles of *Burxton's* water and one bottle of *Hargate's* water.

Find the probability that the total volume in the 5 bottles of *Burxton's* water is more than 5 times the volume in the bottle of *Hargate's* water.

(5)

- (ii) Two independent random samples  $X_1, X_2, X_3, X_4, X_5$  and  $Y_1, Y_2, Y_3, Y_4, Y_5$  are each taken from a normal population with mean  $\mu$  and standard deviation  $\sigma$ .

(a) Find the distribution of the random variable  $D = Y_1 - \bar{X}$

(3)

(b) Hence show that  $P(Y_1 > \bar{X} + \sigma) = 0.181$  correct to 3 decimal places.

(2)

Ankit believes that  $P(U_1 > \bar{U} + \sigma) = 0.181$  correct to 3 decimal places, for **any** random sample  $U_1, U_2, U_3, U_4, U_5$  taken from a normal population with mean  $\mu$  and standard deviation  $\sigma$ .

(c) Explain briefly why the result from part (b) should not be used to confirm Ankit's belief.

(1)

(d) Find, correct to 3 decimal places, the actual value of  $P(U_1 > \bar{U} + \sigma)$ .

(6)

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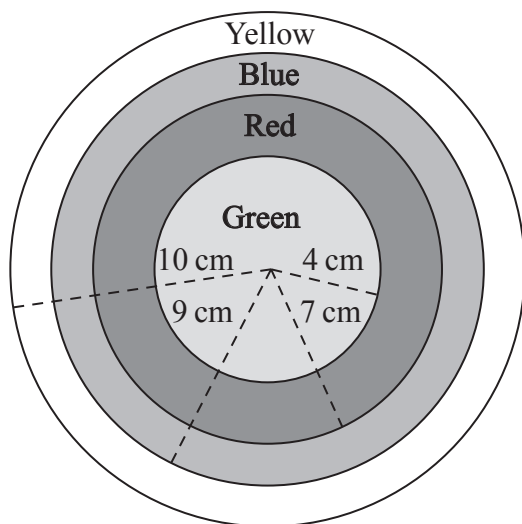
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6.



**Figure 1**

The sketch in Figure 1 represents a target which consists of 4 regions formed from 4 concentric circles of radii 4 cm, 7 cm, 9 cm and 10 cm. The regions are coloured as labelled in Figure 1.

A random sample of 100 children each choose a point on the target and their results are summarised in the table below.

| Colour of region | Green | Red | Blue | Yellow |
|------------------|-------|-----|------|--------|
| Frequency        | 22    | 39  | 25   | 14     |

Caitland is trying to model the distribution of the points chosen by the children. She defines the random variable  $D$  to be the distance, in cm, of a point from the centre of the target and assumes  $D \sim U[0, 10]$ .

- (a) Stating your hypotheses clearly and using a 1% level of significance, test whether or not  $U[0, 10]$  is a suitable model for these data.

(9)

**Question 6 continues on page 18**

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**Question 6 continued**

Henry claims that the points are randomly distributed over the target and the probability of a point being in any particular region is proportional to the area of that region. He calculates expected frequencies and obtains the following table.

|                           |       |     |      |        |
|---------------------------|-------|-----|------|--------|
| <b>Colour of region</b>   | Green | Red | Blue | Yellow |
| <b>Expected frequency</b> | 16    | 33  | $r$  | $s$    |

(b) Find the value of  $r$  and the value of  $s$ . **(3)**

Henry obtained a test statistic of 6.188 and no groups were pooled.

(c) State what conclusion Henry should make about his claim. **(2)**

Phoebe believes that the children chose the region of the target according to colour. She believes that boys and girls would favour different colours and splits the original data by gender to obtain the following table.

**Observed frequencies**

|                         |       |     |      |        |              |
|-------------------------|-------|-----|------|--------|--------------|
| <b>Colour of region</b> | Green | Red | Blue | Yellow | <b>Total</b> |
| <b>Boys</b>             | 10    | 12  | 10   | 3      | 35           |
| <b>Girls</b>            | 12    | 27  | 15   | 11     | 65           |

(d) State suitable hypotheses to test Phoebe's belief. **(1)**

Phoebe calculated the following expected frequencies to carry out a suitable test.

**Expected frequencies**

|                         |       |       |       |        |
|-------------------------|-------|-------|-------|--------|
| <b>Colour of region</b> | Green | Red   | Blue  | Yellow |
| <b>Boys</b>             | 7.7   | 13.65 | 8.75  | 4.9    |
| <b>Girls</b>            | 14.3  | 25.35 | 16.25 | 9.1    |

(e) Show how the value of 25.35 was obtained. **(1)**

Phoebe carried out the test using 2 degrees of freedom and a 10% level of significance. She obtained a test statistic of 1.411

(f) Explain clearly why Phoebe used 2 degrees of freedom. **(1)**

(g) Stating your critical value clearly, determine whether or not these data support Phoebe's belief. **(2)**



