

2. The weights of pears in an orchard are assumed to have unknown mean μ and unknown standard deviation σ .

A random sample of 20 pears is taken and their weights recorded.

The sample is represented by X_1, X_2, \dots, X_{20} . State whether or not the following are statistics. Give reasons for your answers.

(a) (i) $\frac{X_1 + 3X_{20}}{2}$

(ii) $\sum_{i=1}^{20} (X_i - \mu)$

(iii) $\sum_{i=1}^{20} \left(\frac{X_i - \mu}{\sigma} \right)$ (4)

- (b) Find the mean and variance of $\frac{3X_1 - X_{20}}{2}$ (3)



3. A number of males and females were asked to rate their happiness under the headings “not happy”, “fairly happy” and “very happy”.

The results are shown in the table below

| | | Happiness | | | Total |
|--------|--------|-----------|--------------|------------|-------|
| | | Not happy | Fairly happy | Very happy | |
| Gender | Female | 9 | 43 | 34 | 86 |
| | Male | 13 | 25 | 16 | 54 |
| Total | | 22 | 68 | 50 | 140 |

Stating your hypotheses, test at the 5% level of significance, whether or not there is evidence of an association between happiness and gender. Show your working clearly.

(10)



5. A research station is doing some work on the germination of a new variety of genetically modified wheat.

They planted 120 rows containing 7 seeds in each row.

The number of seeds germinating in each row was recorded. The results are as follows

| | | | | | | | | |
|---|---|---|----|----|----|----|----|---|
| Number of seeds germinating in each row | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Observed number of rows | 2 | 6 | 11 | 19 | 25 | 32 | 16 | 9 |

- (a) Write down two reasons why a binomial distribution may be a suitable model. (2)
- (b) Show that the probability of a randomly selected seed from this sample germinating is 0.6 (2)

The research station used a binomial distribution with probability 0.6 of a seed germinating. The expected frequencies were calculated to 2 decimal places. The results are as follows

| | | | | | | | | |
|---|------|------|-----|-------|-----|-------|-------|------|
| Number of seeds germinating in each row | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Expected number of rows | 0.20 | 2.06 | s | 23.22 | t | 31.35 | 15.68 | 3.36 |

- (c) Find the value of s and the value of t . (2)
- (d) Stating your hypotheses clearly, test, at the 1% level of significance, whether or not the data can be modelled by a binomial distribution. (7)



Question 5 continued

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P 4 3 1 5 6 A 0 1 3 2 8

6. A random sample X_1, X_2, \dots, X_n is taken from a population with mean μ .

(a) Show that $\bar{X} = \frac{1}{n}(X_1 + X_2 + \dots + X_n)$ is an unbiased estimator of the population mean μ . **(1)**

A company produces small jars of coffee.

Five jars of coffee were taken at random and weighed.

The weights, in grams, were as follows

197 203 205 201 195

(b) Calculate unbiased estimates of the population mean and variance of the weights of the jars produced by the company. **(3)**

It is known from previous results that the weights are normally distributed with standard deviation 4.8 g.

The manager is going to take a second random sample. He wishes to ensure that there is at least a 95% probability that the estimate of the population mean is within 1.25 g of its true value.

(c) Find the minimum sample size required. **(4)**



8. The heights, in metres, and weights, in kilograms, of a random sample of 9 men are shown in the table below

| Man | A | B | C | D | E | F | G | H | I |
|----------------|------|------|------|------|------|------|------|------|------|
| Height (x) | 1.68 | 1.74 | 1.75 | 1.76 | 1.78 | 1.82 | 1.84 | 1.88 | 1.98 |
| Weight (y) | 75 | 76 | 100 | 77 | 90 | 95 | 110 | 96 | 120 |

(a) Given that $S_{xx} = 0.0632$, $S_{yy} = 1957.5556$ and $S_{xy} = 9.3433$ calculate, to 3 decimal places, the product moment correlation coefficient between height and weight for these men. (2)

(b) Use your value of the product moment correlation coefficient to test whether or not there is evidence of a positive correlation between the height and weight of men. Use a 5% significance level. State your hypotheses clearly. (4)

Peter does not know the heights or weights of the 9 men. He is given photographs of them and asked to put them in order of increasing weight. He puts them in the order

A C E B G D I F H

(c) Find, to 3 decimal places, Spearman's rank correlation coefficient between Peter's order and the actual order. (6)

(d) Use your value of Spearman's rank correlation coefficient to test for evidence of Peter's ability to correctly order men, by their weight, from their photographs. Use a 5% significance level and state your hypotheses clearly. (4)



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Question 8 continued

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Q8

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(Total 16 marks)

TOTAL FOR PAPER: 75 MARKS

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