ROYAL STATISTICAL SOCIETY

EXAMINATIONS OF THE ROYAL STATISTICAL SOCIETY

HIGHER CERTIFICATE IN STATISTICS, 2012

MODULE 3 : Basic statistical methods

Time allowed: One and a half hours

Candidates should answer **THREE** *questions.*

Each question carries 20 marks.
The number of marks allotted for each part-question is shown in brackets.

Graph paper and Official tables are provided.

Candidates may use calculators in accordance with the regulations published in the Society's "Guide to Examinations" (document Ex1).

The notation log *denotes logarithm to base* ***e****.*
Logarithms to any other base are explicitly identified, e.g. $\log_{10}$.

Note also that $\binom{n}{r}$ *is the same as* ${}^{n}C_{r}$.

This examination paper consists of 8 printed pages.
This front cover is page 1.
Question 1 starts on page 2.

There are 4 questions altogether in the paper.

1. The following are the scores on an intelligence test (the IQ) of a sample of 10 students at a large school.

107 99 101 93 99 103 134 132 103 109

Three confidence intervals for the mean IQ for the population of all the students at the school have been calculated using a computer package. The output is shown below.

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Variable   N     Mean    StDev   SE Mean          95% CI
IQ        10  108.000   13.904     4.397   (98.053, 117.947)

Variable   N     Mean    StDev   SE Mean           ? CI
IQ        10  108.000   13.904     4.397   (99.940, 116.060)


Variable   N     Mean    StDev   SE Mean           ? CI
IQ        10  108.000   13.904     4.397   (93.711, 122.289)
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(i) The first interval is a 95% confidence interval. One of the second and third is a 90% confidence interval and the other is a 99% confidence interval. Which is which, and how can you tell?

(2)

(ii) What assumptions have been made in computing the intervals? What distribution has been used in calculating the intervals, and why?

(5)

(iii) Explain the meaning of the above 95% confidence interval as if to a non-statistician.

(3)

(iv) Explain how the standard deviation is computed and how the standard error of the mean is computed.

(3)

(v) Let σ be the population IQ standard deviation. Construct a 95% confidence interval for σ.

(7)

2. (a) A researcher wishes to conduct an experiment to see whether or not consuming alcohol affects the mean reaction time of drivers.

(i) What would be a suitable null hypothesis, and an appropriate alternative hypothesis?

(2)

(ii) What would be the result of making a Type I error and what would be the result of making a Type II error?

(2)

(iii) If one researcher uses a significance level of $\alpha = 0.05$ and another uses a significance level of $\alpha = 0.01$, which would be more likely to make a Type I error and which would be more likely to make a Type II error?

(2)

(b) A test of mental ability has been constructed so that, for adults in the UK, the test score is Normally distributed with mean 100 and standard deviation 15. A doctor needs to test at the 5% significance level whether the mean score of sufferers from a particular disease differs from the mean score of the general population on this test. She has obtained the following test scores for ten randomly selected patients suffering from the disease.

119 131 95 107 125 90 128 89 103 103

(i) Perform the appropriate test and report your conclusions to the doctor.

(8)

(ii) Suppose that, before collecting data, the doctor had suspected that the disease led to a reduction in mental ability. How would that have affected your test and your conclusions?

(2)

(iii) What is the minimum sample size for which a sample mean test score of 109 would be indicative of a significant increase in mental ability at the 1% significance level?

(4)

3. The Managing Director (MD) of a company of auditors has to select a team of five clerical officers for each major audit. He suspects that he may be biased towards left-handed writers and decides to have this suspicion tested statistically. He knows that 20% of his large team of clerical officers are left-handed. His analysis of his last 40 team selections shows the following distribution of the numbers of selected left-handers.

Number of left-handers	0	1	2	3	4	5
Frequency	9	13	9	5	2	2

You are to decide whether or not these figures provide evidence of bias.

(i) Assuming no bias towards or against left-handers, confirm that the expected number of times out of 40 that the MD would choose each of 0, 1, 2, 3, 4 or 5 left-handers in his team is 13.11, 16.38, 8.19, 2.05, 0.26 and 0.01 respectively.

(6)

(ii) Carry out a χ^2 goodness-of-fit test at the 5% significance level to test whether or not the observed distribution might reasonably occur if the MD were not biased. State your hypotheses and your conclusions.

(10)

(iii) Discuss the implications of your test result and the data with respect to the MD's suspicions.

(4)

4. It is of interest to examine whether Choice Reaction Time (CRT) of table-tennis players is reduced by training.

(a) Sixteen table-tennis players took part in a trial in which each was randomly assigned to one of two groups. The first group of eight had not received training, and the second group of eight had received training. The CRT values below are each in hundredths of a second.

Group 1 (no training): 82, 69, 73, 44, 58, 56, 76, 66

Group 2 (after training): 63, 42, 74, 37, 50, 43, 80, 64

(i) Explain why it may be deemed appropriate to use the Wilcoxon rank sum test, and state what null and alternative hypotheses would be tested.

(3)

(ii) Carry out the Wilcoxon rank sum test at the 5% level of significance, and report your conclusions.

(6)

(b) Suppose instead that CRT was measured before and after training on eight randomly selected table-tennis players, with the results given below.

Player	*x (before training)*	*y (after training)*
1	82	63
2	69	42
3	73	74
4	44	37
5	58	50
6	56	43
7	76	80
8	66	64

(i) Explain why it may be deemed appropriate to use the Wilcoxon signed-rank test, and state what null and alternative hypotheses would be tested. Explain also why it may be deemed inappropriate to use the Wilcoxon rank sum test in this case.

(5)

(ii) Carry out the Wilcoxon signed-rank test at the 5% level of significance, and report your conclusions.

(6)

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