

**ADVANCED SUBSIDIARY GCE**  
**MEI STATISTICS**  
Statistics 3 (Z3)

**G243**

Candidates answer on the Answer Booklet

**OCR Supplied Materials:**

- 8 page Answer Booklet
- Graph paper
- MEI Examination Formulae and Tables (MF2)

**Other Materials Required:**

- Scientific or graphical calculator

**Tuesday 15 June 2010**  
**Morning**

**Duration:** 1 hour 30 minutes



**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- This document consists of **4** pages. Any blank pages are indicated.

## Section A (45 marks)

- 1 A student measures the pulse rates of a random sample of 10 runners both before and after they have run round an athletics track. The pulse rates are as follows.

Runner	A	B	C	D	E	F	G	H	I	J
Before	83	75	73	80	88	61	70	77	76	62
After	148	100	98	171	152	94	127	132	170	106

- (i) Draw a scatter diagram to illustrate these data. [3]
- (ii) Calculate the value of the product moment correlation coefficient. [2]
- (iii) Carry out a hypothesis test at the 1% significance level to determine whether there appears to be positive correlation between pulse rate before exercise and pulse rate after exercise, stating your hypotheses. [6]
- (iv) State the distributional assumption which is necessary for this test to be valid. Explain briefly in the light of the scatter diagram why it appears that the assumption may be valid. [2]
- (v) If this distributional assumption is not valid, what alternative test procedure could be performed? If you were to carry out this test, what null hypothesis would you be testing? [2]
- 2 Carrots are supplied to a supermarket chain by two different suppliers. The weights,  $x$  grams, of random samples of carrots from each supplier are summarised as follows.

Supplier A	Sample size $n_A = 100$	$\Sigma x_A = 10\,313$	$\Sigma x_A^2 = 1\,072\,660$
Supplier B	Sample size $n_B = 95$	$\Sigma x_B = 9\,672$	$\Sigma x_B^2 = 986\,540$

- (i) Carry out a test at the 1% significance level to determine whether carrots supplied by the two suppliers have the same mean weight, stating your hypotheses and your conclusion. [12]
- (ii) Explain why it is valid to carry out this test without knowing the population variances. [2]
- (iii) Assuming that the population mean weights are the same, explain why the supermarket chain might prefer carrots from supplier B. [1]

- 3 A researcher is investigating the speed of shipping in the English Channel. She records the speeds in knots of a random sample of 13 tankers and 15 general cargo vessels. The results, given in ascending order, are as follows.

Tanker	5.9	8.3	8.5	9.5	10.9	11.1	11.2	11.5	12.6	13.4	13.7	13.9	15.1		
General cargo vessels	9.6	10.6	11.3	12.0	12.5	12.7	13.1	13.2	13.5	13.8	14.5	16.1	16.7	17.0	24.4

The researcher wishes to investigate whether, on average, the speeds of tankers and the speeds of general cargo vessels are the same. The underlying populations are not considered to be Normally distributed.

- (i) State suitable null and alternative hypotheses for a test which can be performed to investigate whether, on average, the speeds are the same. Carry out the test at the 5% significance level. [10]
- (ii) Name a test which could be performed if the population distributions were Normal. What property of the variances of the two populations is required to perform this test? [3]
- (iii) If, instead, the numbers of tankers and general cargo vessels in the sample were the same, would it be appropriate to carry out a signed rank test? Briefly explain your answer. [2]

**[Question 4 is printed overleaf.]**

**Section B** (27 marks)

4 As part of a large construction project, over the course of three weeks a large number of lorries deliver liquid concrete to the project site. In order to check the quality of the concrete, a number of samples of concrete are selected. For each sample, a small quantity of liquid concrete is taken from a lorry and left to harden. It is then tested for compressive strength.

(i) Explain what population is being sampled in this case. [2]

The project engineer considers a number of methods of conducting the sampling.

- Choose a single day and sample all of the lorries which arrive on that day.
- Sample the first lorry which arrives on each day.
- On each day, select a lorry at random from the lorries due to arrive on that day.

(ii) Comment briefly on whether each of these methods is likely to result in a representative sample. [3]

(iii) If there were a list of all of the concrete deliveries expected at the site during the three weeks, explain briefly how a simple random sample of size 15 could be selected. [3]

The concrete is supplied by two different companies, A and B. The project engineer wishes to test whether there is any difference in the mean compressive strength of the concrete supplied by the two companies. The sampling process results in 9 samples from Company A and 6 samples from Company B. The compressive strengths, measured in suitable units, are summarised as follows.

Company A	$n = 9$	Sample mean 4.210	Sample standard deviation 0.2482
Company B	$n = 6$	Sample mean 4.295	Sample standard deviation 0.2459

(iv) State appropriate null and alternative hypotheses for a  $t$  test to determine whether there is any evidence that the mean compressive strengths of the concrete from the two companies are different. An assumption required for this test is equality of population variances. What other distributional assumption is required? Carry out the test at the 5% level. [13]

At a later stage in the project, a further large quantity of concrete is required. The project engineer again checks the quality of the concrete from each company. For a period of 10 days he takes two samples per day, one from a lorry belonging to Company A and one from a lorry belonging to Company B. He suspects that the weather conditions on each day may have an effect on the quality of the concrete. He wishes to check if the mean compressive strengths of the concrete supplied by the two companies are equal.

(v) Explain briefly why a paired  $t$  test should be carried out in this situation. [2]

(vi) The project engineer carries out a paired  $t$  test. He calculates the usual  $t$  statistic for this situation and finds this value to be 2.31. Complete the test, using a 5% significance level, stating your conclusion clearly. [4]

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