

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	



General Certificate of Education
Advanced Level Examination
June 2014

Statistics

SS06

Unit Statistics 6

Monday 23 June 2014 9.00 am to 10.30 am

For this paper you must have:

- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed

- 1 hour 30 minutes

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.



J U N 1 4 S S 0 6 0 1

Answer **all** questions.

Answer each question in the space provided for that question.

- 1** An investigation was carried out into the colour of the tail feathers of hybrid Northern Flicker birds. Some birds had one odd tail feather that was different in colour or length from the other typical tail feathers because it was regrown after being lost.

The yellowness of the one odd tail feather on each of 16 birds was measured and compared with the yellowness of one typical tail feather from the same bird.

The 'yellowness index' of a typical tail feather and that of the odd tail feather were found for each bird. A lower 'yellowness index' value indicates a lighter shade of yellow.

The results are given in the table.

		Yellowness index	
		Typical feather	Odd feather
Bird	1	−0.255	−0.324
	2	−0.213	−0.185
	3	−0.190	−0.299
	4	−0.185	−0.144
	5	−0.045	−0.027
	6	−0.025	−0.039
	7	−0.015	−0.264
	8	0.003	−0.077
	9	0.015	−0.017
	10	0.020	−0.169
	11	0.023	−0.096
	12	0.040	−0.330
	13	0.040	−0.346
	14	0.050	−0.191
	15	0.055	−0.128
	16	0.058	−0.180

- (a) State **two** assumptions that must be made for a paired t -test on the given data to be valid.

[2 marks]

- (b) Using the 1% level of significance, investigate the claim that odd tail feathers are a lighter shade of yellow than typical tail feathers on Northern Flicker birds.

[10 marks]



QUESTION
PART
REFERENCE

Answer space for question 1

A large rectangular area with horizontal dotted lines for writing an answer.

Turn over ►



QUESTION
PART
REFERENCE

Answer space for question 1

A large rectangular area containing horizontal dotted lines for writing an answer.



QUESTION
PART
REFERENCE

Answer space for question 1

A large rectangular area with horizontal dotted lines for writing an answer.

Turn over ►



2 *Best4Tiles* orders large batches of 20 kg bags of floor levelling compound from a manufacturer. The weights of the contents of these bags are known to be normally distributed with a standard deviation of 0.6 kg.

Before *Best4Tiles* accepts a batch of these bags, a sample of 5 bags is taken at random and the contents of each bag are weighed. The batch is accepted if the mean weight of the contents of the 5 bags exceeds 19.6 kg.

(a) The table on the page opposite shows the probability of acceptance, $P(A)$, of a batch for different mean weights.

(i) Complete the table on the page opposite.

[3 marks]

(ii) Draw the operating characteristic for this sampling plan on the grid on the page opposite.

[2 marks]

(iii) Comment on the suitability of this sampling plan.

[1 mark]

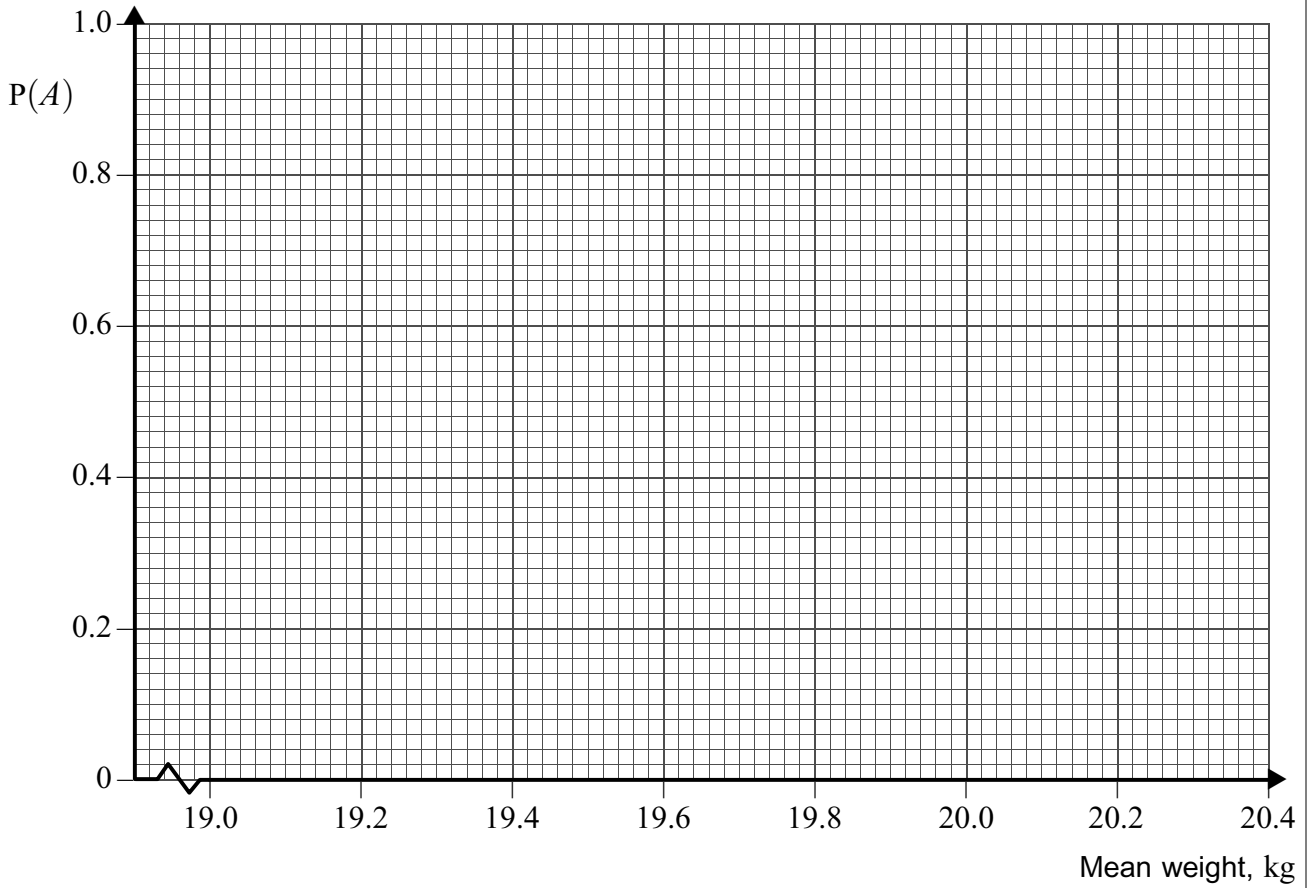
QUESTION
PART
REFERENCE

Answer space for question 2(a)



Answer space for question 2(a)

Mean weight, kg	19.2	19.4	19.6	19.8	20.0	20.2	20.4
P(A)	0.068			0.772	0.932		



QUESTION
PART
REFERENCE

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 2 continues on the next page

Turn over ►



2 (b) It is decided that this acceptance sampling plan should be reviewed.

- (i) *Best4Tiles* would like to use a new sampling plan in which the probability of acceptance of a batch with a mean weight of 19.4 kg is at most 0.05 when a random sample of 4 bags is taken.

Using this new sampling plan, find the smallest value for w , the weight that must be exceeded by the mean weight of the contents of the sample of 4 bags, for the batch to be accepted.

Assume that the weights of the contents of bags are still normally distributed with a standard deviation of 0.6 kg.

[4 marks]

- (ii) After reviewing the sampling plan, the manufacturer decides that it would prefer the probability of acceptance of a batch with a mean weight of 20 kg to be at least 0.96 when, for acceptance of the batch, the mean weight of the contents of a sample of n bags must exceed 19.6 kg.

Find the minimum value for n that satisfies the manufacturer's preference.

Assume that the weights of the contents of bags are still normally distributed with a standard deviation of 0.6 kg.

[4 marks]

QUESTION
PART
REFERENCE

Answer space for question 2(b)



QUESTION
PART
REFERENCE

Answer space for question 2(b)

A large rectangular area with horizontal dotted lines for writing.

Turn over ►



3 *Inqa* is a company that assembles optical components. Every hour, a scoop is used to obtain a sample of the components assembled during that hour for inspection.

The data given in the table are the result of the inspection of components assembled during each of ten consecutive hours of production.

	Hour									
	1	2	3	4	5	6	7	8	9	10
Number of components inspected	80	110	90	75	130	120	70	125	105	95
Number of non-conforming components	4	7	5	7	7	6	4	5	8	7

(a) Use the data in the table to estimate p , the proportion of non-conforming components, and n , the average number of components sampled per hour.

[3 marks]

(b) Use your estimates found in part (a) to calculate the upper 95% warning and upper 99.8% action control limits for the proportion of non-conforming components.

[4 marks]

(c) By making further calculations, and using your control limits found in part (b), comment on the state of production of assembled components at *Inqa* during these ten hours.

[4 marks]

(d) Recommend the action, if any, that you would advise *Inqa* to take if the number of non-conforming components found in a sample of 85 from those assembled during the next hour was:

- (i) 3;
- (ii) 12.

[4 marks]

QUESTION
PART
REFERENCE

Answer space for question 3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



QUESTION
PART
REFERENCE

Answer space for question 3

A large rectangular area with horizontal dotted lines for writing an answer.

Turn over ►



QUESTION
PART
REFERENCE

Answer space for question 3

A large rectangular area containing horizontal dotted lines for writing an answer.



QUESTION
PART
REFERENCE

Answer space for question 3

A large rectangular area with horizontal dotted lines for writing an answer.

Turn over ►



4 The pharmaceutical company, *Abetter*, wishes to test the effectiveness of a new safe vaccine developed to immunise people against the common cold. The new vaccine is to be tested against a placebo vaccine.

To test the vaccine using a pilot study, *Abetter* has 20 volunteers, A, B, C, ..., T. The sex and age of each of these volunteers are shown in the table.

Volunteer	A	B	C	D	E	F	G	H	I	J
Sex	M	M	M	M	M	M	M	M	M	M
Age (years)	23	42	35	25	61	44	54	35	57	66

Volunteer	K	L	M	N	O	P	Q	R	S	T
Sex	F	F	F	F	F	F	F	F	F	F
Age (years)	42	62	56	24	33	47	28	67	51	34

The three suggested designs for this investigation are completely randomised, randomised block and matched pairs.

(a) Produce a table layout, together with an explanation, to indicate how *Abetter* should allocate the 20 volunteers to the two treatments of placebo vaccine and new vaccine so that the design is:

- (i) completely randomised;
- (ii) randomised block;
- (iii) matched pairs.

[6 marks]

(b) Give an advantage for the investigation of using a design that is:

- (i) completely randomised;
- (ii) randomised block;
- (iii) matched pairs.

[3 marks]

(c) State, with a reason, which one of the three designs you would recommend to *Abetter* for this investigation.

[2 marks]

QUESTION
PART
REFERENCE

Answer space for question 4

.....

.....

.....

.....



QUESTION
PART
REFERENCE

Answer space for question 4

A large rectangular area with horizontal dotted lines for writing an answer.



QUESTION
PART
REFERENCE

Answer space for question 4

A large rectangular area containing horizontal dotted lines for writing an answer.



QUESTION
PART
REFERENCE

Answer space for question 4

A large rectangular area with horizontal dotted lines for writing an answer.



- 5 Soneya, the owner of TipleY Café, believes that people cannot tell the difference between the first cup of tea made with a given teabag and the second and third cups made with the same teabag.

She chooses seven different brands of teabag and, for each brand in turn, she selects one teabag and makes a first cup, a second cup and a third cup of tea with it.

Soneya then asks one of her regular tea-drinking customers to taste each cup of tea, for each brand in turn, and rate it on a scale of 0 to 20. A higher rating indicates a better tasting tea.

The making order and the brand of tea used are unknown to the customer.

The customer's ratings are given in **Table 1**.

Table 1

		Making order		
		First	Second	Third
Tea brand	A	8	3	2
	B	15	14	4
	C	16	17	12
	D	7	5	4
	E	9	3	6
	F	8	9	4
	G	10	3	4
Total		73	54	36

$$\sum_i \sum_j x_{ij}^2 = 1705$$

- (a) (i) Making any necessary assumptions, carry out F -tests, using the 5% level of significance, to investigate for a difference between the ratings for the three making orders and for the seven brands.

[12 marks]

- (ii) Make recommendations to Soneya based on your conclusions in part (a)(i).

[2 marks]

- (b) (i) State the assumption that is necessary regarding the interaction of factors when carrying out the tests in part (a)(i). Interpret this assumption in context.

- (ii) State **two** other necessary assumptions regarding the given data when carrying out the test in part (a)(i).

[4 marks]



QUESTION
PART
REFERENCE

Answer space for question 5(a) and (b)

Area with horizontal dotted lines for writing answers.

Question 5 continues on page 22

Turn over ►



QUESTION
PART
REFERENCE

Answer space for question 5(a) and (b)

A large rectangular area with horizontal dotted lines for writing answers.



QUESTION
PART
REFERENCE

Answer space for question 5(a) and (b)

Area with horizontal dotted lines for writing answers.

Question 5 continues on the next page

Turn over ►



5 (c) Soneya then decides to investigate the tea brands and asks each of 10 regular tea-drinking customers to rate a cup of tea made using a Brand B teabag and one made using a Brand C teabag.

The difference in the ratings, Brand B – Brand C, for each of these 10 customers, is given in **Table 2**.

Table 2

	Customer									
	1	2	3	4	5	6	7	8	9	10
Difference in ratings	-8	2	-4	0	-1	-3	-6	-5	-7	3

Carry out a Wilcoxon signed-rank test to investigate whether there is a difference between the average rating given to tea made using a Brand B teabag and that given to tea made using a Brand C teabag. Use the 5% level of significance.

[5 marks]

QUESTION
PART
REFERENCE

Answer space for question 5(c)



QUESTION
PART
REFERENCE

Answer space for question 5(c)

A large rectangular area with horizontal dotted lines for writing an answer.

END OF QUESTIONS



There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

Acknowledgement of copyright-holders and publishers

Question 1: Karen L Wiebe and Gary R Bortolotti, Variation in carotenoid-based flickers in a hybrid zone, Wilson Journal of Ornithology, 2002

Copyright © 2014 AQA and its licensors. All rights reserved.

