A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

For Examiner's Use

AS
STATISTICS

Unit Statistics 3

SS03

Friday 15 June 2018 Afternoon

Time allowed: 1 hour 30 minutes

For this paper you must have:
- **the blue AQA booklet of formulae and statistical tables.**

You may use a graphics calculator.

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

JUN18SS0301

INSTRUCTIONS

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- 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 on blank pages.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work 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.

DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions.

Answer each question in the space provided for that question.

1 A pre-school booster vaccination is offered to all children aged three years. This vaccination can be injected into the arm or into the thigh.

Very rarely, a reaction is experienced by the child receiving this vaccination.

An investigation was carried out into whether there is an association between a child suffering a reaction and the location of the injection.

For the 5000 children involved in the investigation, the summarised results are given in the table. These children may be regarded as a random sample.

		Location of injection	
		Arm	Thigh
Reaction	No	3220	1737
	Yes	24	19

Carry out a hypothesis test, at the 10% level of significance, to investigate whether reaction and location of injection are associated.

You should interpret your findings in the context of the question. [8 marks]

	Answer space for Question 1 **Write the question part reference in the left margin**

	Answer space for Question 1 **Write the question part reference in the left margin**

	Answer space for Question 1 Write the question part reference in the left margin

[Turn over]

2 **Ernie, an ecologist, was concerned about the levels of aluminium that accumulate in the wood of poplar trees growing in polluted areas.**

A poplar tree was selected in each of 13 different polluted areas and the aluminium content, in micrograms per gram of wood, was measured for each tree in August 2014 and again in November 2014.

Ernie wanted to investigate whether the average aluminium content in poplar trees increased from August 2014 to November 2014.

The results are given in the table.

	Aluminium content	
Area	August 2014	November 2014
1	18.3	12.7
2	13.3	11.1
3	16.5	15.3
4	12.6	12.7
5	9.5	10.5
6	13.6	15.6
7	8.1	11.2
8	8.9	14.2
9	10.0	16.3
10	8.3	15.5
11	7.9	19.9
12	8.1	20.4
13	13.4	36.8

Carry out a Wilcoxon signed-rank test, at the 1% level of significance, to investigate whether the average aluminium content in poplar trees was higher in November 2014 than in August 2014. [9 marks]

[Turn over]

	Answer space for Question 2 **Write the question part reference in the left margin**

	Answer space for Question 2 Write the question part reference in the left margin

	Answer space for Question 2 **Write the question part reference in the left margin**

BLANK PAGE

[Turn over]

3 **A male frigate bird has a large red throat sac that it inflates to attract female frigate birds. It uses its inflated throat sac to make drumming sounds.**

Female frigate birds have been observed to favour males with the largest inflated throat sac.

Diego, an animal behaviourist, claims that female frigate birds detect the frequency of the drumming sounds as an indicator of the size of a male's inflated throat sac.

Diego records information about 11 male frigate birds. His estimated volume of each male's inflated throat sac, x cm^3, and the corresponding measured drumming frequency, y hertz, are given in the table.

Table of results cannot be reproduced here due to third-party copyright restrictions.

(a) (i) **Find the value of Spearman's rank correlation coefficient between x and y [5 marks]**

(ii) **Interpret the value of the correlation coefficient obtained in part (a)(i). [2 marks]**

(b) **Carry out a hypothesis test, using the 5% level of significance, to investigate whether your value of the correlation coefficient calculated in part (a)(i) indicates a negative association between volume of inflated throat sac and drumming frequency.**

You should include a comment on Diego's claim. [5 marks]

	Answer space for Question 3 Write the question part reference in the left margin

	Answer space for Question 3 **Write the question part reference in the left margin**

	Answer space for Question 3 **Write the question part reference in the left margin**

	Answer space for Question 3 **Write the question part reference in the left margin**

	Answer space for Question 3 Write the question part reference in the left margin

	Answer space for Question 3 **Write the question part reference in the left margin**

	Answer space for Question 3 **Write the question part reference in the left margin**

[Turn over]

4 Raafi, a psychologist, was interested in a suggestion that physical exercise can alleviate depression. Raafi recruited 16 of his moderately depressed patients for an investigation.

Each patient was randomly assigned to one of three daily exercise regimes for one month: 'No exercise', '20 minutes of gentle jogging' or '60 minutes of gentle jogging'.

At the end of the month, patients were asked to score their current states of mind on a scale of 0 – 30, where 0 indicates 'completely miserable' and 30 represents 'ecstatically happy'.

The state of mind score for each patient is given in the table.

Daily exercise regime		
No exercise	20 minutes jogging	60 minutes jogging
6	8	17
12	11	18
13	17	20
11	16	23
9	12	15
	19	

(a) Carry out a distribution-free test, using the 5% level of significance, to determine whether there is evidence of a difference, on average, between the state of mind scores for the three exercise regimes.

Interpret your conclusion in the context of this question. [12 marks]

(b) The patient who scored her current state of mind at the end of the month as 15, admitted that she had stopped doing her daily exercise regime after 2 weeks.

Explain how this new information may affect, if at all, your conclusion in part (a). [2 marks]

(c) Give a reason for the patients being randomly assigned to an exercise regime. [2 marks]

	Answer space for Question 4 Write the question part reference in the left margin

	Answer space for Question 4 **Write the question part reference in the left margin**

	Answer space for Question 4 Write the question part reference in the left margin

	Answer space for Question 4 **Write the question part reference in the left margin**

	Answer space for Question 4 Write the question part reference in the left margin

	Answer space for Question 4 **Write the question part reference in the left margin**

	Answer space for Question 4 Write the question part reference in the left margin

[Turn over]

5 Tilly, the operations manager at a tyre production company, wants to investigate whether there is any association between the quality of a tyre and the shift during which it was produced.

Tilly obtains a random sample of 500 tyres and records, for each tyre, its quality as 'Excellent', 'Satisfactory' or 'Defective, and the shift during which it was produced as 1, 2 or 3.

Her results are summarised in the table.

		Shift			
		1	2	3	Total
Quality	Excellent	77	89	58	224
	Satisfactory	86	72	87	245
	Defective	11	13	7	31
	Total	174	174	152	500

(a) Investigate, at the 10% significance level, whether tyre quality is independent of shift. [12 marks]

(b) By comparing observed and expected frequencies, identify, in context, TWO deductions concerning tyre quality and shift. [4 marks]

	Answer space for Question 5 **Write the question part reference in the left margin**

	Answer space for Question 5 **Write the question part reference in the left margin**

	Answer space for Question 5 Write the question part reference in the left margin

	Answer space for Question 5 **Write the question part reference in the left margin**

	Answer space for Question 5 Write the question part reference in the left margin

	Answer space for Question 5 **Write the question part reference in the left margin**

	Answer space for Question 5 Write the question part reference in the left margin

[Turn over]

BLANK PAGE

6 (a) **Twenty healthy female international flight attendants, aged between 26 years and 32 years were selected for an investigation into the effects of jet-lag. Each attendant had more than five years' service with an airline company.**

Ten of the flight attendants were randomly selected from those working for airlines with short recovery periods of 5 days or fewer between outbound long haul flights.

The other ten flight attendants were randomly selected from those working for airlines with long recovery periods of more than 14 days between outbound long haul flights.

Each flight attendant was asked to complete a task that assessed her reaction time two days into her recovery period.

The reaction time, in milliseconds, for each flight attendant is given in TABLE 1.

[Turn over]

TABLE 1

Recovery period	
Short	**Long**
735	635
783	638
787	688
802	712
819	719
849	769
860	774
902	786
905	843
927	903

Carry out a distribution-free test, using the 2.5% level of significance, to investigate whether female flight attendants with short recovery periods have, on average, slower reaction times than those with long recovery periods. [9 marks]

	Answer space for Question 6(a) Write the question part reference in the left margin

	Answer space for Question 6(a) Write the question part reference in the left margin

BLANK PAGE

[Turn over]

(b) **A different investigation was carried out into the incidence and level of hearing loss in flight attendants with more than five years' service.**

Each of eleven randomly selected flight attendants was paired by age, sex and general health, with a server who had more than five years' service in a busy restaurant.

The level of hearing, in decibels (dB), was measured for each person in the investigation.

A person with normal hearing has a measurement of between –10 dB and +15 dB. A higher dB measurement indicates a greater hearing loss.

The results are given in TABLE 2.

TABLE 2

	Pair										
	A	B	C	D	E	F	G	H	I	J	K
Flight Attendant	18	28	20	12	8	43	15	55	18	21	15
Server	14	12	31	7	10	19	–1	17	32	11	–5

Carry out a sign test, at the 10% level of significance, to investigate whether flight attendants suffer, on average, from greater hearing loss than servers in busy restaurants. [5 marks]

	Answer space for Question 6(b) Write the question part reference in the left margin

	Answer space for Question 6(b) Write the question part reference in the left margin

	Answer space for Question 6(b) Write the question part reference in the left margin

END OF QUESTIONS

BLANK PAGE

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

Copyright information

For confidentiality purposes, from the November 2015 examination series, acknowledgements of third party copyright material will be published in a separate booklet rather than including them on the examination paper or support materials. This booklet is published after each examination series and is available for free download from www.aqa.org.uk after the live examination series.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team, AQA, Stag Hill House, Guildford, GU2 7XJ.

Copyright © 2018 AQA and its licensors. All rights reserved.