Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

AS
STATISTICS

Unit Statistics 3

Friday 15 June 2018 Afternoon Time allowed: 1 hour 30 minutes

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

You may use a graphics calculator.

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 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.

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

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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]

QUESTION PART REFERENCE	**Answer space for Question 1**

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QUESTION PART REFERENCE	Answer space for Question 1

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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]

QUESTION PART REFERENCE	**Answer space for Question 2**

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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]

QUESTION PART REFERENCE	**Answer space for Question 3**

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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]

QUESTION PART REFERENCE	**Answer space for Question 4**

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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]

QUESTION PART REFERENCE	**Answer space for Question 5**

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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**.

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]

QUESTION PART REFERENCE	**Answer space for Question 6(a)**

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(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]

QUESTION PART REFERENCE	**Answer space for Question 6(b)**

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QUESTION PART REFERENCE	Answer space for Question 6(b)

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