Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

AS
STATISTICS

Unit Statistics 3

Friday 17 June 2016 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 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.

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Answer **all** questions.

Answer each question in the space provided for that question.

1 An investigation into the effects of caffeine consumption on coordination and processing skills was carried out by a drinks company.

Ten university students, who normally consumed fewer than three caffeinated drinks per week, agreed to participate in this investigation.

The students agreed to perform several tasks involving hand-eye coordination on two separate occasions.

Students were randomly assigned to have either a caffeinated drink or an uncaffeinated drink thirty minutes before they performed the tasks on the first occasion.

One week later they returned to perform the tasks again. Thirty minutes before the students performed the tasks on the second occasion, those who were given a caffeinated drink on the first occasion were given an uncaffeinated drink and those who were given an uncaffeinated drink on the first occasion were given a caffeinated drink.

The scores gained by each student for the hand-eye coordination tasks were on a scale of 0 to 50, where 50 indicates the highest level of hand-eye coordination.

The scores for each student on each occasion are given in the table.

Student	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Caffeinated drink	28	39	38	40	41	26	36	37	22	33
Uncaffeinated drink	32	30	34	37	42	21	34	29	21	27

(a) Carry out a Wilcoxon signed-rank test, at the 5% significance level, to investigate whether the consumption of a caffeinated drink has any effect on the median score gained in the hand-eye coordination tasks.

[9 marks]

(b) (i) Write down **two** assumptions that must be made in order for the test in part **(a)** to be valid.

(ii) Explain, in the context of this question, the meaning of a Type I error.

[4 marks]

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2 Twelve adults, all of whom suffered from moderate lower back pain, agreed to take part in an investigation into the effectiveness of a commonly recommended painkiller used for the relief of back pain.

They were each given tablets and instructed to take one tablet four times a day. They were also instructed to keep moving as much as possible and asked to record how many days it took for the pain to go away completely.

The adults were randomly assigned to take either tablets containing the recommended painkiller or placebo tablets that contained no active ingredient.

The numbers of days taken by each patient for the back pain to go away completely are given in the table.

Recommended painkiller tablets	13	20	18	16	15	21
Placebo tablets	16	19	17	14	23	22

(a) Carry out a distribution-free test, using the $2\frac{1}{2}\%$ level of significance, to investigate whether the patients taking the recommended painkiller had, on average, fewer days to wait for their back pain to go away completely.

[9 marks]

(b) Give a reason why all the adults were given tablets and the same instructions.

[1 mark]

QUESTION PART REFERENCE

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3 A university psychology department decided to investigate whether background music improves concentration.

Sixteen final-year university students participated in this investigation.

Each student was allocated to one of three rooms. One room had background music with lyrics, one room had background music without lyrics, and one room had no background music.

The students were all given the same reading task and, on completion, were asked questions about its content.

The numbers of correct answers given by the students are shown in the table.

Type of background music		
With lyrics	**Without lyrics**	**None**
21	27	31
19	32	28
30	34	38
25	26	36
22	24	29
27		

You may assume that the 16 students form a random sample.

Carry out a Kruskal-Wallis test, using the 5% level of significance, to determine whether there is evidence of a difference, on average, between the numbers of correct answers given for the three types of background music.

Interpret your conclusion in the context of this question including a suggestion to final-year university students about reading with background music.

[12 marks]

QUESTION PART REFERENCE

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4 A UK national newspaper conducted a survey on the eating preferences of its readers.

A sample of 300 readers, aged between 40 years and 50 years and supporters of one of five political parties, were asked to state which of the following food types they preferred: British, French or Italian.

They were also asked to state the political party that they supported. Readers could select the political party that they supported from five political parties labelled A, B, C, D and E.

The results are summarised in the table.

		Food type preferred			
		British	**French**	**Italian**	**Total**
Political party supported	**A**	29	21	25	75
	B	29	39	22	90
	C	13	11	26	50
	D	20	8	7	35
	E	15	18	17	50
Total		106	97	97	300

These 300 readers may be regarded as a random sample.

(a) Investigate, at the 5% significance level, whether food type preferred is independent of political party supported.

[11 marks]

(b) By comparing observed and expected frequencies, identify, in context, **three** deductions concerning food type preferred and political party supported.

[4 marks]

(c) Give **two** reasons why conclusions from this survey may not necessarily apply to all UK residents.

[2 marks]

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5 Fatima, a film reviewer, was asked to investigate the level of gender bias in films.

A random sample of 12 films, released during 2010, was obtained.

Fatima watched the 12 films and then assigned to each of them a gender bias score based on the importance of the female characters in the film and on how well-rounded their roles were.

The score assigned was measured on a scale of 0 to 20, where 20 indicated the **least** gender bias.

For each film, the gender bias score assigned and the **rank** of the gross box office takings, where rank 1 indicates the highest takings, are given in **Table 1**.

Table 1

		Gender bias score	Rank of gross box office takings
Film	**A**	15	2
	B	18	$10\frac{1}{2}$
	C	19	9
	D	8	7
	E	10	$10\frac{1}{2}$
	F	17	3
	G	13	4
	H	20	12
	I	13	1
	J	16	8
	K	12	6
	L	14	5

Fatima decided to quantify the correlation between gender bias score and gross box office takings.

(a) (i) Calculate an appropriate measure of correlation.

[5 marks]

(ii) Carry out a hypothesis test, using the 10% level of significance, to investigate whether the correlation coefficient calculated in part **(a)(i)** indicates an association between gender bias score and gross box office takings.

[4 marks]

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5 (b) Information was also available about the running time, in minutes, and the budget, in \$ million, for making the film for each of the 12 films in Fatima's sample.

This information is given in **Table 2**.

Table 2

		Running time	Budget
Film	A	135	125
	B	118	110
	C	91	5
	D	120	40
	E	117	110
	F	95	15
	G	108	13
	H	101	20
	I	95	69
	J	100	60
	K	113	80
	L	140	155

Arthur, Fatima's assistant, believed that films that had a longer running time also had a larger budget.

(i) Find the value of the product moment correlation coefficient between running time and budget.

[3 marks]

(ii) Hence carry out a hypothesis test, using the 1% level of significance, to investigate Arthur's belief.

[4 marks]

(iii) State, in context, the distributional assumption necessary for the test in part **(b)(ii)** to be valid.

[2 marks]

(iv) Arthur also suspected that films released during 2010 had a longer average running time than those released during 2015. The median running time in 2015 was 106 minutes.

Carry out a sign test, at the 10% level of significance, to investigate Arthur's suspicion.

[5 marks]

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