

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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# A-level MATHEMATICS

## Unit Statistics 3

Monday 25 June 2018

Morning

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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
<b>TOTAL</b>	



Answer **all** questions.

Answer each question in the space provided for that question.

- 1** Alfie, Bishen and Chao are three male students. They selected, each from a different population, a random sample of 12 pairs of measurements.

Each student then calculated the value of the product moment correlation coefficient,  $r$ , based on his pairs of measurements.

The values obtained are shown in the table.

Student	Value of $r$ obtained
Alfie	-0.732
Bishen	0.556
Chao	1.207

Each student intended to use his value of  $r$  to test the null hypothesis  $H_0 : \rho = 0$  against the alternative hypothesis  $H_1 : \rho > 0$ , where  $\rho$  denotes the product moment correlation coefficient for the population from which his sample was selected.

- (a)** Name the two students for whom it is unnecessary to carry out the test. Give a justification for each student that you select.

**[2 marks]**

- (b)** Carry out the test, using the 5% level of significance, for the other student.

**[3 marks]**

QUESTION  
PART  
REFERENCE

**Answer space for question 1**









**3** Manufacturer *CoMB* has three factories, A, B and C, which produce computer motherboards.

Factory A produces 25%, factory B produces 35% and factory C produces 40% of *CoMB*'s motherboards.

The **percentage** of non-conforming motherboards produced by each factory is shown in the table.

Factory	Percentage of non-conforming motherboards
<b>A</b>	1.5
<b>B</b>	1.0
<b>C</b>	0.5

**(a)** Calculate the probability that a randomly selected motherboard produced by *CoMB*:

**(i)** is non-conforming;

**[2 marks]**

**(ii)** was produced at factory C, given that it is non-conforming.

**[2 marks]**

**(b)** Calculate the probability that in three randomly selected non-conforming motherboards produced by *CoMB*, one was produced at factory A, one was produced at factory B and one was produced at factory C.

**[3 marks]**

**(c)** *CoMB* closes factory A and moves its production of motherboards to factory C. This has no effect on the percentages of non-conforming motherboards produced by factories B and C.

Calculate the probability that, following this change, a randomly selected motherboard produced by *CoMB* was produced at factory C, given that it is non-conforming.

**[3 marks]**

QUESTION  
PART  
REFERENCE

**Answer space for question 3**



















- 5** Lorna, a statistician, is also a keen gardener. Over many years, she has established the following summary information on the time, in minutes, for each of the tasks that she carries out to maintain her property's lawns.

Task	Variable	Mean	Variance
Get out equipment	$U$	5	1
Mow grass	$V$	30	25
Trim edges	$W$	15	9
Sweep up and clean equipment	$X$	25	16
Put away equipment	$Y$	10	4

- (a) (i) The random variables  $V$  and  $W$  are such that  $\rho_{VW} = 0.80$ .

Determine values for the mean and the variance of  $M = V + W$ .

**[3 marks]**

- (ii) The random variables  $M$ ,  $U$ ,  $X$  and  $Y$  are independent.

Determine values for the mean and the variance of  $D = M - (U + X + Y)$ .

**[2 marks]**

- (b) Assuming that each of the variables  $M$  and  $D$  is approximately normally distributed, determine the probability that Lorna takes:

- (i) more than one hour to mow the grass and trim the edges of her property's lawns;  
(ii) less time to mow the grass and trim the edges of her property's lawns than to carry out the other lawn maintenance tasks.

**[5 marks]**

QUESTION  
PART  
REFERENCE

**Answer space for question 5**











**6 (a)** The random variable  $X$  has the distribution  $B(n, p)$  for which  $E(X) = np$ .

(i) Prove that  $\text{Var}(X) = np(1 - p)$ .

[5 marks]

(ii) Show that  $P(X = x) = \left(\frac{n - x + 1}{x}\right) \left(\frac{p}{1 - p}\right) P(X = x - 1)$ .

[2 marks]

**(b)** The random variable  $Y$  has a binomial distribution with  $E(Y) = 7.5$  and  $P(Y = 8) = P(Y = 7)$ .

Find the value of  $\text{Var}(Y)$ .

[3 marks]

**(c)** The random variable  $U$  has a binomial distribution with  $E(U) = 5$  and  $\text{Var}(U) = 4.995$ .

Use a distributional approximation to estimate  $P(U \leq 3)$ . Justify your choice of distributional approximation.

[3 marks]

**(d)** The random variable  $V$  has a binomial distribution with  $E(V) = 60.5$  and  $P(V = 61) = P(V = 60)$ .

Use a distributional approximation to estimate  $P(V > 50)$ .

[3 marks]

QUESTION  
PART  
REFERENCE

**Answer space for question 6**





















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