Please check the examination details below before entering your candidate information		
Candidate surname		Other names
Pearson Edexcel Level 3 GCE	Centre Number	Candidate Number
Friday 14 Ju	ne 2019	
Afternoon	Paper F	Reference <b>9MA0-31</b>
<b>Mathematics</b> Advanced Paper 31: Statistics		
<b>You must have:</b> Mathematical Formulae and S	tatistical Tables, ca	alculator

## Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

## Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 50. There are 5 questions.
- The marks for **each** question are shown in brackets – use this as a guide as to how much time to spend on each question.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.









Three bag	gs, $A$ , $B$ and $C$ , each contain 1 red marble and some green marbles.	
Bag B	4 contains 1 red marble and 9 green marbles only 8 contains 1 red marble and 4 green marbles only 7 contains 1 red marble and 2 green marbles only	
If he select If the mar If he select	ects at random one marble from bag <i>A</i> . cts a red marble, he stops selecting. rble is green, he continues by selecting at random one marble from bag <i>B</i> . cts a red marble, he stops selecting. rble is green, he continues by selecting at random one marble from bag <i>C</i> .	
(a) Draw	a tree diagram to represent this information.	(2)
(b) Find t	the probability that Sasha selects 3 green marbles.	(2) (2)
(c) Find t	the probability that Sasha selects at least 1 marble of each colour.	(2)
(d) Given	n that Sasha selects a red marble, find the probability that he selects it from	-
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	(Total for Question 2 is 11 marks)	J

Barbara is investigating the relationship between average income (GDP per capita), $x$ US and average annual carbon dioxide (CO <sub>2</sub> ) emissions, $y$ tonnes, for different countries.	S dollars,
She takes a random sample of 24 countries and finds the product moment correlation coefficient between average annual $CO_2$ emissions and average income to be 0.446	
(a) Stating your hypotheses clearly, test, at the 5% level of significance, whether or not the product moment correlation coefficient for all countries is greater than zero.	(3)
Barbara believes that a non-linear model would be a better fit to the data. She codes the data using the coding $m = \log_{10} x$ and $c = \log_{10} y$ and obtains the model $c = -1.82 + 0.89m$	
The product moment correlation coefficient between $c$ and $m$ is found to be 0.882	
(b) Explain how this value supports Barbara's belief.	(1)
(c) Show that the relationship between <i>y</i> and <i>x</i> can be written in the form $y = ax^n$ where <i>a</i> and <i>n</i> are constants to be found.	(5)
	(5)

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4.	Magali is studying the mean total cloud cover, in oktas, for Leuchars in 1987 using data
	from the large data set. The daily mean total cloud cover for all 184 days from the large
	data set is summarised in the table below.

Daily mean total cloud cover (oktas)	0	1	2	3	4	5	6	7	8
Frequency (number of days)	0	1	4	7	10	30	52	52	28

One of the 184 days is selected at random.

(a) Find the probability that it has a daily mean total cloud cover of 6 or greater.

Magali is investigating whether the daily mean total cloud cover can be modelled using a binomial distribution.

She uses the random variable X to denote the daily mean total cloud cover and believes that  $X \sim B(8, 0.76)$ 

Using Magali's model,

(b) (i) find  $P(X \ge 6)$ 

(ii) find, to 1 decimal place, the expected number of days in a sample of 184 days with a daily mean total cloud cover of 7

(c) Explain whether or not your answers to part (b) support the use of Magali's model.

(1)

(2)

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(1)

There were 28 days that had a daily mean total cloud cover of 8 For these 28 days the daily mean total cloud cover for the **following** day is shown in the table below.

Daily mean total cloud cover (oktas)	0	1	2	3	4	5	6	7	8
Frequency (number of days)	0	0	1	1	2	1	5	9	9

(d) Find the proportion of these days when the daily mean total cloud cover was 6 or greater. (1)

(e) Comment on Magali's model in light of your answer to part (d).



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	You should state your hypotheses clearly.	(5)
	<ul><li>She takes a random sample of 20 bottles and finds the mean amount of liquid to be 24.94 ml</li><li>(c) Test Hannah's belief at the 5% level of significance.</li></ul>	
	Following the adjustments, Hannah believes that the mean amount of liquid put in each bottle is less than 25 ml	
	The machine is adjusted so that the standard deviation of the liquid put in the bottles is now 0.16 ml	~ /
	(b) Using a normal approximation, find the probability that fewer than half of these bottles contain between 24.63 ml and $k$ ml	(3)
	A random sample of 200 bottles is taken.	
	(a) find, to 2 decimal places, the value of k such that $P(24.63 < D < k) = 0.45$	(5)
	Given that 15% of bottles contain less than 24.63 ml	
	Dml, follows a normal distribution with mean 25 ml	

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	(Total for Question 5 is 13 marks)