

Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel  
Level 3 GCE**

Centre Number

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Candidate Number

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**Wednesday 20 May 2020**

Morning

Paper Reference **8MA0/21**

**Mathematics  
Advanced Subsidiary  
Paper 21: Statistics**

**You must have:**

Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

**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.
- Values from statistical tables should be quoted in full. If a calculator is used instead of tables the value should be given to an equivalent degree of accuracy.
- Inexact 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 30. 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.

Turn over ►

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1.

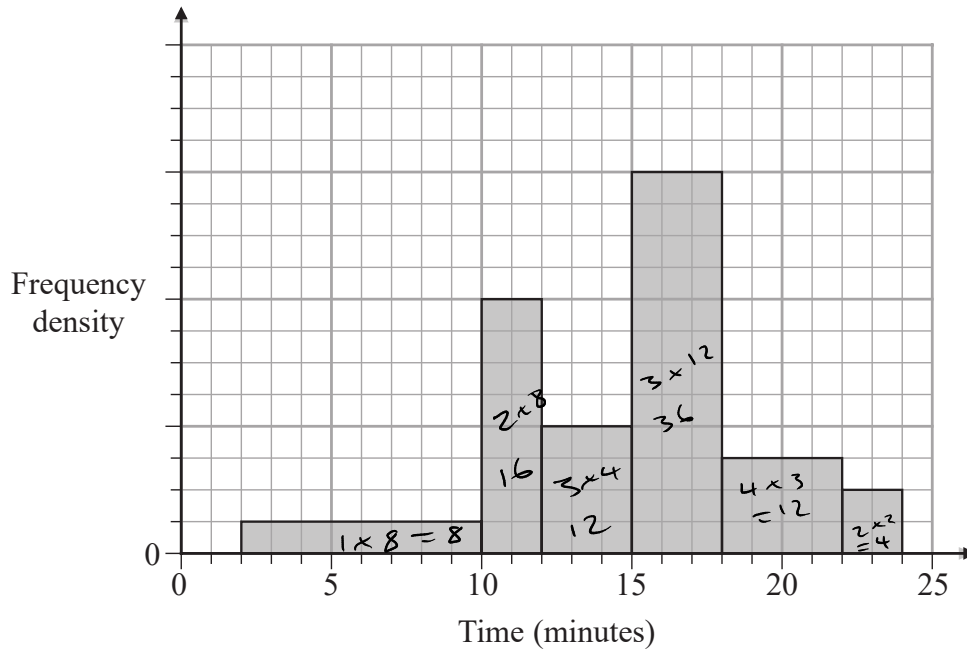


Figure 1

The histogram in Figure 1 shows the times taken to complete a crossword by a random sample of students.

The number of students who completed the crossword in more than 15 minutes is 78

Estimate the percentage of students who took less than 11 minutes to complete the crossword.

(4)

$$\left[ \begin{array}{l} 52 \text{ squares about 15 mins} \\ \frac{78}{52} = 1.5 \text{ each square is 1.5 students} \end{array} \right] \leftarrow \text{This isn't needed to answer the question}$$

88 squares in total

16 squares less than 11 mins

$$\frac{16}{88} \times 100 = \underline{\underline{18.2\%}} \quad (358)$$





2. Jerry is studying visibility for Camborne using the large data set June 1987.

The table below contains two extracts from the large data set.

It shows the daily maximum relative humidity and the daily mean visibility.

Date	Daily Maximum Relative Humidity	Daily Mean Visibility
Units	%	
10/06/1987	90	5300
28/06/1987	100	0

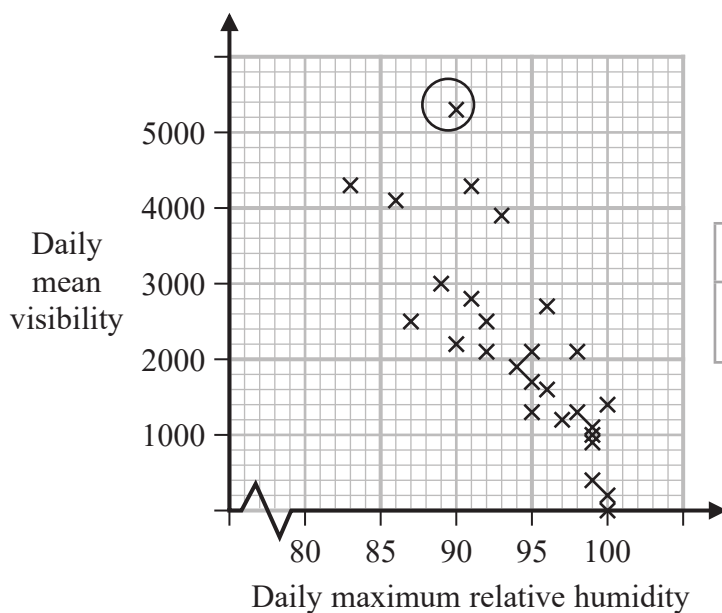
(The units for Daily Mean Visibility are deliberately omitted.) *dm*

Given that daily mean visibility is given to the nearest 100,

(a) write down the range of distances in metres that corresponds to the recorded value 0 for the daily mean visibility.

(1)

Jerry drew the following scatter diagram, Figure 2, and calculated some statistics using the June 1987 data for Camborne from the large data set.



	$Q_1$	IQR
Daily mean visibility	1100	1600
Daily maximum relative humidity (%)	92	8

Figure 2

Jerry defines an outlier as a value that is more than 1.5 times the interquartile range above  $Q_3$  or more than 1.5 times the interquartile range below  $Q_1$ .

(b) Show that the point circled on the scatter diagram is an outlier for visibility.

(2)

(c) Interpret the correlation between the daily mean visibility and the daily maximum relative humidity.

(1)



Jerry drew the following scatter diagram, Figure 3, using the June 1987 data for Camborne from the large data set, but forgot to label the  $x$ -axis.

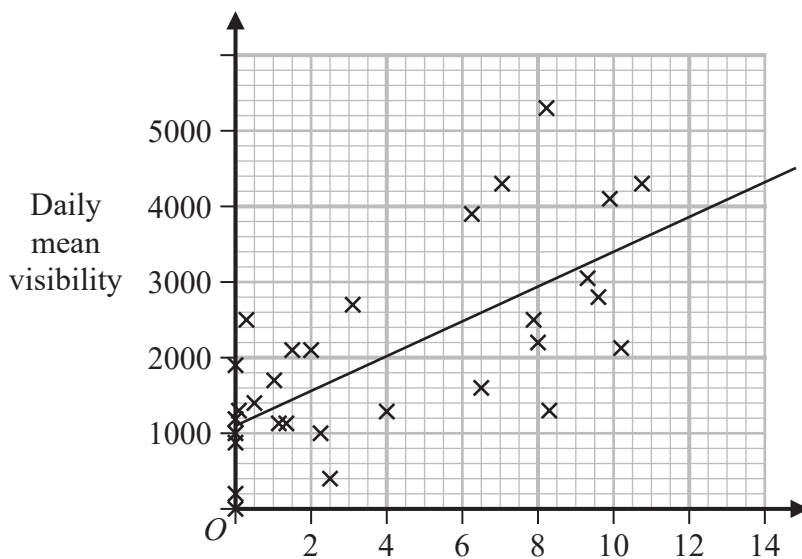


Figure 3

(d) Using your knowledge of the large data set, suggest which variable the  $x$ -axis on this scatter diagram represents.

(1)

a/  $0 \leq d < 50$  (dm)  $1 \text{ dm} = 10 \text{ m}$

$0 \leq d < 500$  (m)

b/  $Q_3 = 1100 + 1600 = 2700$

$1.5 \times IQR = 2400$

$2700 + 2400 = \underline{5100}$

$5300 > 5100$   $\therefore$  outlier

c/ As daily maximum relative humidity increases daily mean visibility decreases

d/ Hours of sunshine





Question 2 continued

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Handwriting practice area consisting of horizontal lines.

(Total for Question 2 is 5 marks)



P 6 3 9 3 5 A 0 7 1 6

3. In a game, a player can score 0, 1, 2, 3 or 4 points each time the game is played.

The random variable  $S$ , representing the player's score, has the following probability distribution where  $a$ ,  $b$  and  $c$  are constants.

$s$	0	1	2	3	4
$P(S=s)$	$a$	$b$	$c$	0.1	0.15

The probability of scoring less than 2 points is twice the probability of scoring at least 2 points.

Each game played is independent of previous games played.

John plays the game twice and adds the two scores together to get a total.

Calculate the probability that the total is 6 points.

(6)

$$a + b = 2(c + 0.1 + 0.15)$$

$$a + b = 2c + 0.2 + 0.3$$

$$a + b = 2c + 0.5$$

$$a + b - 2c = 0.5$$

$$a + b + c + 0.1 + 0.15 = 1$$

$$a + b + c = 0.75$$

$$a + b + c = 0.75$$

$$a + b - 2c = 0.5$$

$$3c = 0.25$$

$$c = \frac{1}{12}$$

$$\begin{aligned} \text{To score 6 } P(4, 2) &= 0.15 \times \frac{1}{12} = \frac{1}{80} \\ 2, 4 &= \frac{1}{12} \times 0.15 = \frac{1}{80} \\ 3, 3 &= 0.1 \times 0.1 = \frac{1}{100} \end{aligned}$$

$$P(6) = \frac{1}{80} + \frac{1}{80} + \frac{1}{100}$$

$$= \frac{7}{200}$$





**Question 3 continued**

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A series of horizontal lines for writing, starting from the top of the page below the question title and extending down to just above the bottom text. The lines are evenly spaced and cover the majority of the page area.

**(Total for Question 3 is 6 marks)**



P 6 3 9 3 5 A 0 9 1 6

4. A lake contains three different types of carp.

There are an estimated 450 mirror carp, 300 leather carp and 850 common carp.

Tim wishes to investigate the health of the fish in the lake.

He decides to take a sample of 160 fish.

- (a) Give a reason why stratified random sampling cannot be used. (1)
- (b) Explain how a sample of size 160 could be taken to ensure that the estimated populations of each type of carp are fairly represented.

You should state the name of the sampling method used. (2)

As part of the health check, Tim weighed the fish.

His results are given in the table below.

Weight ( $w$ kg)	Frequency ( $f$ )	Midpoint ( $m$ kg)
$2 \leq w < 3.5$	8	2.75
$3.5 \leq w < 4$	32	3.75
$4 \leq w < 4.5$	64	4.25
$4.5 \leq w < 5$	40	4.75
$5 \leq w < 6$	16	5.5

(You may use  $\sum fm = 692$  and  $\sum fm^2 = 3053$ )

- (c) Calculate an estimate for the standard deviation of the weight of the carp. (2)

Tim realised that he had transposed the figures for 2 of the weights of the fish.

He had recorded in the table 2.3 instead of 3.2 and 4.6 instead of 6.4

- (d) Without calculating a new estimate for the standard deviation, state what effect
- (i) using the correct figure of 3.2 instead of 2.3
- (ii) using the correct figure of 6.4 instead of 4.6

would have on your estimated standard deviation.

Give a reason for each of your answers. (2)

a) He would need a register of all of the fish (a sampling frame)



Question 4 continued

b/ Quota sampling

$$450 + 300 + 850 = 1600$$

He needs 45 Mirror, 30 leather and 85 common.

He would catch fish of every type until the quota is full. Any fish caught after a quota is filled would be ignored.

$$c/ \sigma = \sqrt{\frac{\sum fm^2}{n} - \left(\frac{\sum fm}{n}\right)^2}$$

$$\sigma = \sqrt{\frac{3053}{160} - \left(\frac{692}{160}\right)^2}$$

$$\sigma = 0.613 \text{ (3sf)}$$

d/

i/ 2.3 and 3.2 are in the same group. The estimator will be unchanged

ii/ Increase  $\sigma$

$$\text{mean} = \frac{692}{160} = 4.325$$

$$\text{new mean} = \frac{693.8}{160} = 4.33625$$

The Midpoint - mean will be greater.

$$(6.25 \text{ or } 6.5) - 4.336 > 4.75 - 4.325$$







5. Afrika works in a call centre.

She assumes that calls are independent and knows, from past experience, that on each sales call that she makes there is a probability of  $\frac{1}{6}$  that it is successful.

Afrika makes 9 sales calls.

(a) Calculate the probability that at least 3 of these sales calls will be successful. (2)

The probability of Afrika making a successful sales call is the same each day.

Afrika makes 9 sales calls on each of 5 different days.

(b) Calculate the probability that at least 3 of the sales calls will be successful on exactly 1 of these days. (2)

Rowan works in the same call centre as Afrika and believes he is a more successful salesperson.

To check Rowan's belief, Afrika monitors the next 35 sales calls Rowan makes and finds that 11 of the sales calls are successful.

(c) Stating your hypotheses clearly test, at the 5% level of significance, whether or not there is evidence to support Rowan's belief. (4)

$$X \sim B\left(9, \frac{1}{6}\right)$$

$$a/ \quad P(X \geq 3) = 1 - P(X \leq 2)$$

$$= 1 - 0.8217$$

$$= \underline{\underline{0.178}} \quad (3 \text{ s.f.})$$

Binomial CD
$x = 2$
$n = 9$
$p = 1 \div 6$

$$b/ \quad 0.178 \times 0.822 \times 0.822 \times 0.822 \times 0.822 = 0.0813$$

5 different combinations (can happen on M, T, W, Thu or F)

$$5 \times 0.0813 = \underline{\underline{0.406}}$$

$$c/ \quad H_0: \quad p = \frac{1}{6}$$

$$H_1: \quad p > \frac{1}{6}$$



Question 5 continued

$$\frac{11}{35}$$

$$P(X \geq 11) = 1 - P(X \leq 10)$$

$$= 1 - 0.977$$

$$= 0.0232$$

Binomial CD

$$x = 10$$

$$N = 35$$

$$p = 1 \div 6$$

$0.02 < 0.05 \quad \therefore$  we can reject  $H_0$  and accept  $H_1$ .  
There is evidence to suggest Rowan has more successful calls.



