

# OCR

Oxford Cambridge and RSA

## Wednesday 6 June 2018 – Morning

### AS GCE/Level 3 Certificate

### QUANTITATIVE METHODS (MEI)

#### G244/01 Introduction to Quantitative Methods (IQM)

#### Question Paper

Candidates answer on the Question Paper.

**OCR supplied materials:**

- Insert (inserted)

**Other materials required:**

- Scientific or graphical calculator

**Duration:** 1 hour 30 minutes



|                    |  |                   |  |
|--------------------|--|-------------------|--|
| Candidate forename |  | Candidate surname |  |
|--------------------|--|-------------------|--|

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

#### INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the spaces provided. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided.** If additional answer space is required you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the barcodes.
- You are permitted to use a scientific or graphical calculator in this paper unless the question states otherwise.
- Final answers should be given to a degree of accuracy appropriate to the context.

#### INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The Insert contains a copy of the pre-release material for use with three of the questions.
- The total number of marks for this paper is **72**.
- This Question Paper consists of **20** pages. Any blank pages are indicated.

**BLANK PAGE**

**PLEASE DO NOT WRITE ON THIS PAGE**

- 1 This question is based on pre-release material.

The article ‘Exoplanet discovery’ includes the following sentence.

The planets closely circle a dwarf star named Trappist-1, which at 39 light years away makes the system a prime candidate to search for signs of life.

To 4 significant figures, the speed of light is  $1.079 \times 10^9$  kilometres per hour.

Find the distance in kilometres of the star Trappist-1 from the Earth, giving your answer in standard form correct to 2 significant figures. **[4]**

|          |  |
|----------|--|
| <b>1</b> |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |

- 2 Fig. 2.1 shows the first few rows of a column in a spreadsheet. Only three of the cells have been completed.

|     | A   |
|-----|-----|
| 1   | 5   |
| 2   | 10  |
| 3   | 20  |
| 4   | ... |
| 5   | ... |
| ... | ... |

Fig. 2.1

The formula in cell A2 is shown in Fig. 2.2.

|       |
|-------|
| =A1*2 |
|-------|

Fig. 2.2

This formula is copied down the column as far as cell A20.

- (i) Write down the **number** in cell A6. [1]
- (ii) Write down the **formula** in cell A20. [1]
- (iii) Which cell contains the number 163 840? [3]

|                |  |
|----------------|--|
| <b>2 (i)</b>   |  |
|                |  |
|                |  |
| <b>2 (ii)</b>  |  |
|                |  |
|                |  |
| <b>2 (iii)</b> |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |

3 This question is based on the article ‘Crime figures for a Devon town’ in the pre-release material.

(i) Show the calculation that gave rise to the headline ‘Recorded crime drops in Town by 16%’ and explain briefly how the answer was interpreted. [3]

(ii) Find the percentage of crimes in Totnes Town in 2016 that were classified as shoplifting. Compare this with the corresponding figures for Totnes East and Totnes West for the same year.

Suggest a reason for the difference. [4]

|               |  |
|---------------|--|
| <b>3 (i)</b>  |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
| <b>3 (ii)</b> |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |

4 This question is based on the article ‘Lightning strike’ in the pre-release material.

In parts (i) and (ii) of this question, you should assume that over the next 10 years there will be 34 million females in the UK and 33 million males and that these figures will remain constant.

You should also use the most recent figures from the insert for ‘Average fatalities/year’ and ‘% male’.

(i) Give your answers to this part to the nearest whole number.

Estimate the number of people who will die from lightning strike in the UK in the next 10 years.

Estimate also how many of them will be male and how many female. [2]

(ii) Show that the risk to a particular female of being killed by lightning strike in the UK next year is about 1 in 100 million.

What is the corresponding figure for a male? [4]

(iii) Give a plausible explanation as to why the risks of being killed by lightning strike in the UK are so different for males and females. [1]

|               |  |
|---------------|--|
| <b>4 (i)</b>  |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
| <b>4 (ii)</b> |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |

|                |  |
|----------------|--|
| <b>4 (iii)</b> |  |
|                |  |
|                |  |
|                |  |
|                |  |

**(iv)** Estimate the probability that someone who is struck by lightning in the UK survives the incident. [2]

|               |  |
|---------------|--|
| <b>4 (iv)</b> |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |

5 Asif is a bowling coach for cricket players. The length of a cricket pitch is 22 yards and Asif teaches people how to bowl the ball so that its first bounce is at a suitable place on the pitch.

Asif gives the bowlers the frequency chart in Fig. 5.1. It shows the distances in yards from the bowler’s end that he expects 120 of their deliveries to land. It is based on a Normal distribution.

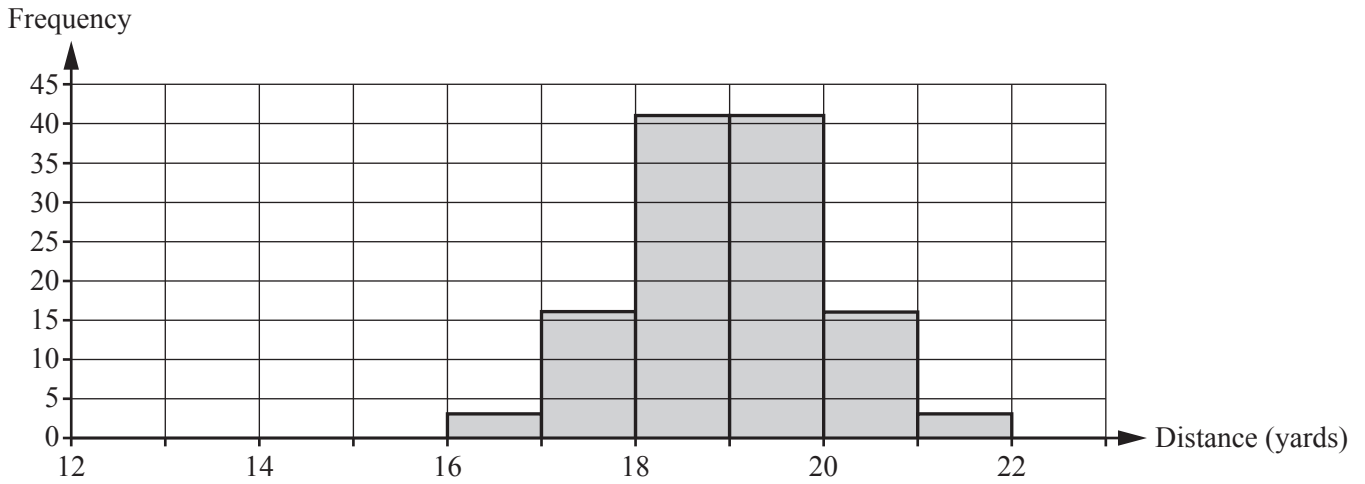


Fig. 5.1

(i) (A) Identify one feature of Asif’s graph that confirms that it is consistent with a Normal distribution. [1]

(B) Write down the mean of the distribution. [1]

(ii) The standard deviation of the distribution is 1 yard.

Show that the frequencies for 16–17 yards and 21–22 yards should both be 3 (as shown in Fig. 5.1). [4]

|        |     |
|--------|-----|
| 5 (i)  | (A) |
|        |     |
|        | (B) |
|        |     |
| 5 (ii) |     |
|        |     |
|        |     |
|        |     |
|        |     |
|        |     |



Charlie is a bowler. Asif keeps a record of 120 balls that Charlie bowls and constructs the frequency chart below (Fig. 5.2).

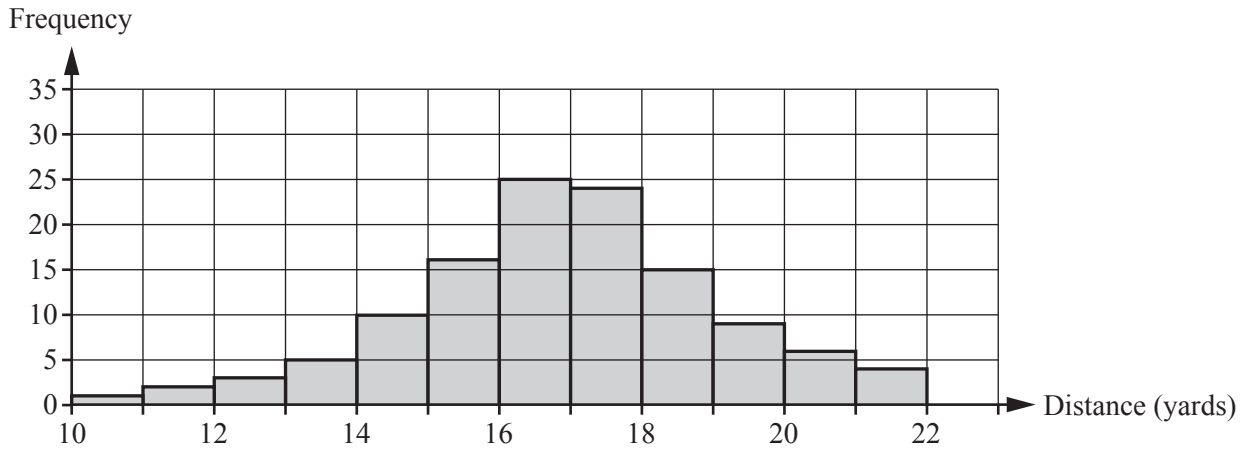


Fig. 5.2

(iii) Give two comments on how Charlie’s bowling compares with what Asif is expecting. [2]

|                |  |
|----------------|--|
| <b>5 (iii)</b> |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |
|                |  |

- 6 Vicky is a folk singer. She gives concerts in village halls in the area where she lives. When deciding how much to charge for tickets she uses the demand curve in Fig. 6.1. This is based on experience from previous concerts.

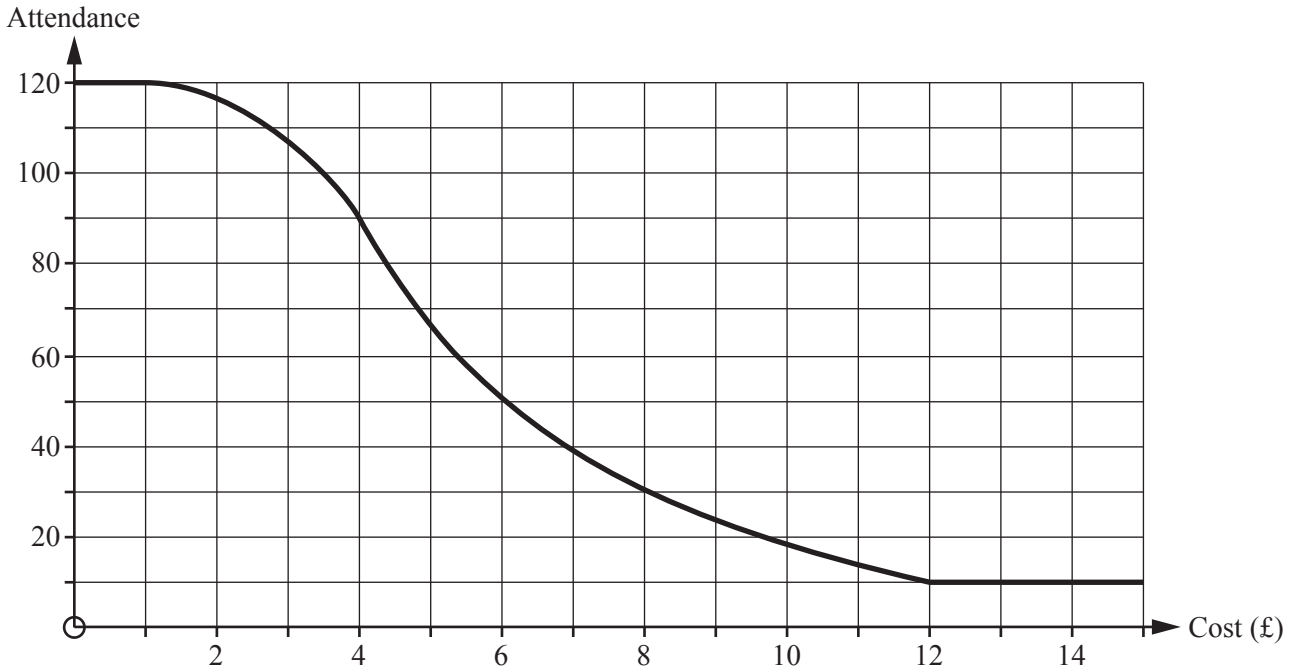


Fig. 6.1

- (i) How many people does Vicky expect if she charges £6? [1]
- (ii) Vicky has a group of loyal supporters who will come to her concerts whatever the cost, up to £25.  
How many people are in this category? [1]

|               |  |
|---------------|--|
| <b>6 (i)</b>  |  |
| <b>6 (ii)</b> |  |

Vicky pays £120 for the hire of the hall.

(iii) Complete this spreadsheet (Fig. 6.2), showing Vicky’s expected income, costs and profit when she charges various prices for the entrance tickets. [3]

(iv) There are formulae in cells C2 and E2 and they are copied down their columns.

Write down the formulae in cells C2 and E6. [2]

(v) State, with a reason, how much you would advise Vicky to charge for a ticket, given that she wants it to a whole number of pounds. [1]

|                 |           |                         |                   |                   |                 |                   |
|-----------------|-----------|-------------------------|-------------------|-------------------|-----------------|-------------------|
| <b>6 (iii)</b>  |           | <b>A</b>                | <b>B</b>          | <b>C</b>          | <b>D</b>        | <b>E</b>          |
|                 | <b>1</b>  | <b>Ticket price (£)</b> | <b>Attendance</b> | <b>Income (£)</b> | <b>Hall (£)</b> | <b>Profit (£)</b> |
|                 | 2         | 0                       | 120               | 0                 | 120             | -120              |
|                 | 3         | 1                       | 120               | 120               | 120             | 0                 |
|                 | 4         | 2                       | 117               | 234               | 120             | 114               |
|                 | 5         | 3                       | 107               | 321               | 120             | 201               |
|                 | 6         | 4                       |                   |                   |                 |                   |
|                 | 7         | 5                       | 66                | 330               | 120             | 210               |
|                 | 8         | 6                       |                   |                   |                 |                   |
|                 | 9         | 7                       | 39                | 273               | 120             | 153               |
|                 | 10        | 8                       | 30                | 240               | 120             | 120               |
|                 | 11        | 9                       | 23                | 207               | 120             | 87                |
|                 | 12        | 10                      | 18                | 180               | 120             | 60                |
|                 | 13        | 11                      | 14                | 154               | 120             | 34                |
|                 | 14        | 12                      | 10                | 120               | 120             | 0                 |
|                 | 15        | 13                      | 10                | 130               | 120             | 10                |
|                 | 16        | 14                      |                   |                   |                 |                   |
| 17              | 15        | 10                      | 150               | 120               | 30              |                   |
| <b>Fig. 6.2</b> |           |                         |                   |                   |                 |                   |
| <b>6 (iv)</b>   | <b>C2</b> |                         |                   |                   |                 |                   |
|                 |           |                         |                   |                   |                 |                   |
|                 | <b>E6</b> |                         |                   |                   |                 |                   |
| <b>6 (v)</b>    |           |                         |                   |                   |                 |                   |
|                 |           |                         |                   |                   |                 |                   |

Vicky realises that her concert will be on the same evening as the final of a very popular competition on television. She estimates this will reduce total attendance by 60%.

(vi) For what ticket price will Vicky just break even?

For what prices will she still make a profit?

[5]

|               |  |
|---------------|--|
| <b>6 (vi)</b> |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |
|               |  |

**BLANK PAGE**

**Question 7 begins on page 14**

**PLEASE DO NOT WRITE ON THIS PAGE**

7 (a) Table 7 below refers to weekday trains from London Paddington to Plymouth. For each train it gives the scheduled times of departure and arrival, the duration of the journey in minutes and the number of station stops along the way.

(i) Complete the three missing figures from the 'Journey time' column.

[2]

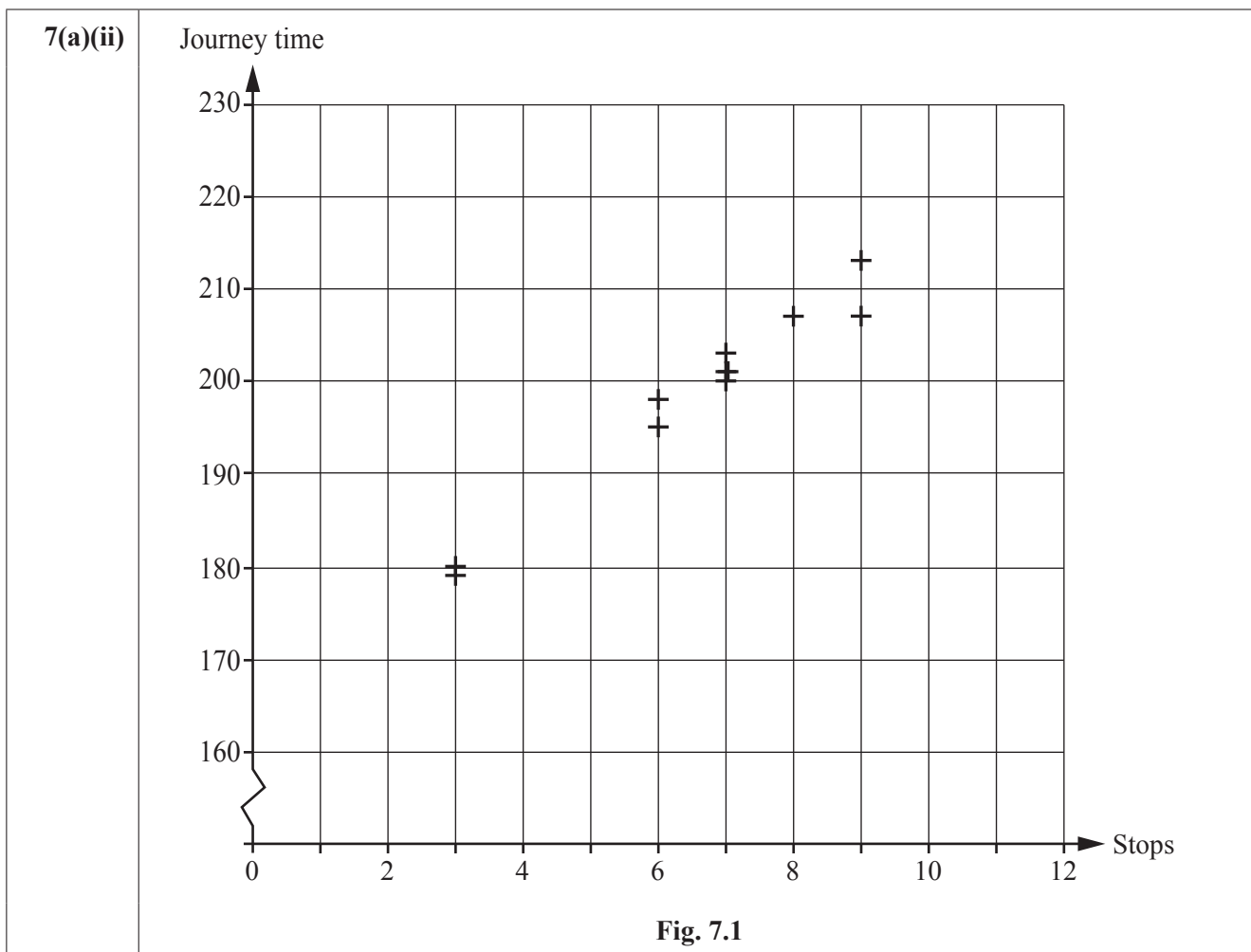
|                |                                 |                             |                          |                                   |
|----------------|---------------------------------|-----------------------------|--------------------------|-----------------------------------|
| <b>7(a)(i)</b> | <b>Paddington<br/>Departure</b> | <b>Plymouth<br/>Arrival</b> | <b>Station<br/>stops</b> | <b>Journey time<br/>(Minutes)</b> |
|                | 0706                            | 1033                        | 9                        | 207                               |
|                | 0906                            | 1227                        | 7                        | 201                               |
|                | 1006                            | 1305                        | 3                        | 179                               |
|                | 1106                            | 1433                        | 8                        | 207                               |
|                | 1205                            | 1505                        | 3                        | 180                               |
|                | 1305                            | 1623                        | 6                        | 198                               |
|                | 1406                            | 1721                        | 6                        | 195                               |
|                | 1506                            | 1839                        | 9                        | 213                               |
|                | 1606                            | 1926                        | 7                        | 200                               |
|                | 1703                            | 2024                        | 7                        | 201                               |
|                | 1803                            | 2118                        | 5                        |                                   |
|                | 1903                            | 2226                        | 7                        | 203                               |
|                | 1945                            | 2325                        | 11                       |                                   |
| 2035           | 0011                            | 10                          |                          |                                   |
| <b>Table 7</b> |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |
|                |                                 |                             |                          |                                   |

- (ii) In Fig. 7.1, the journey times,  $t$ , for these trains are plotted against the number of stops,  $n$ , but three of the points are missing. Mark in the missing points.

Draw the line with equation  $t = 165 + 5n$  on the graph. [4]

- (iii) Comment on whether the line  $t = 165 + 5n$  is a good model, justifying your answer.

Interpret the numbers 165 and 5 in this equation. [3]



**7(a)(iii)**

---



---



---



---



---

(iv) Make  $n$  the subject of the equation  $t = 165 + 5n$ .

Use your answer to estimate the number of stops for a special train taking 4 hours and 1 minute from London Paddington to Plymouth.

[3]

|                 |  |
|-----------------|--|
| <b>7(a)(iv)</b> |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |
|                 |  |



- (b) (i) Fig. 7.2 is a speed-time graph modelling a train approaching, stopping at and leaving a station. Speed is in metres per second ( $\text{m s}^{-1}$ ) and time is in seconds (s).  
[There is another copy of Fig. 7.2 for you to refer to on page 18.]

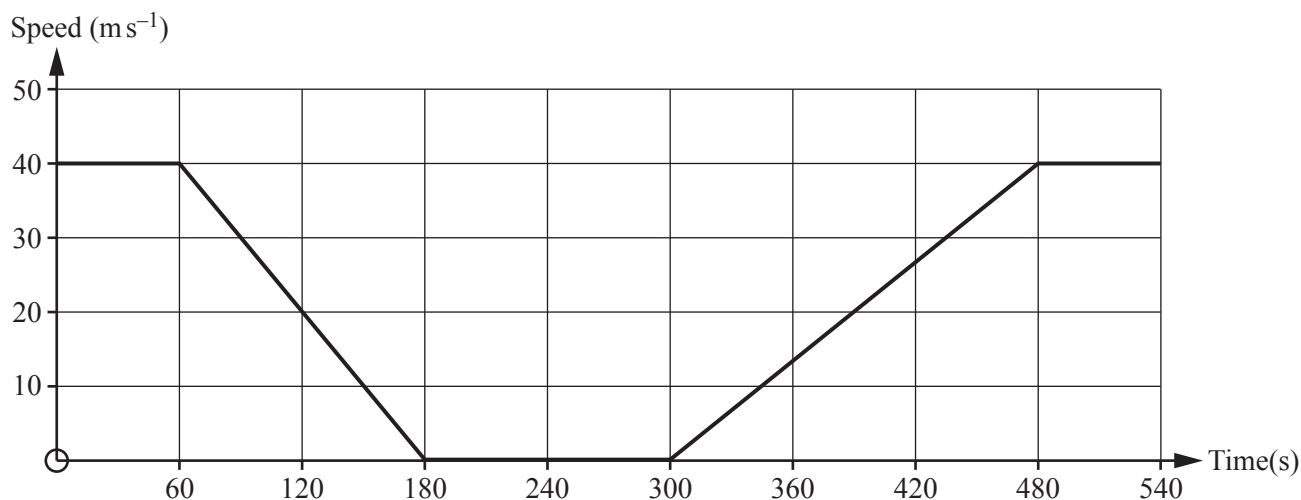


Fig. 7.2

Use the graph to find the number of minutes for which the train was stationary at the station.

Find also the number of minutes for which the train was **not** travelling at full speed of  $40 \text{ m s}^{-1}$ . [2]

|         |  |
|---------|--|
| 7(b)(i) |  |
|         |  |
|         |  |
|         |  |

- (ii) According to this model, the maximum speed of the train was  $40 \text{ m s}^{-1}$ .

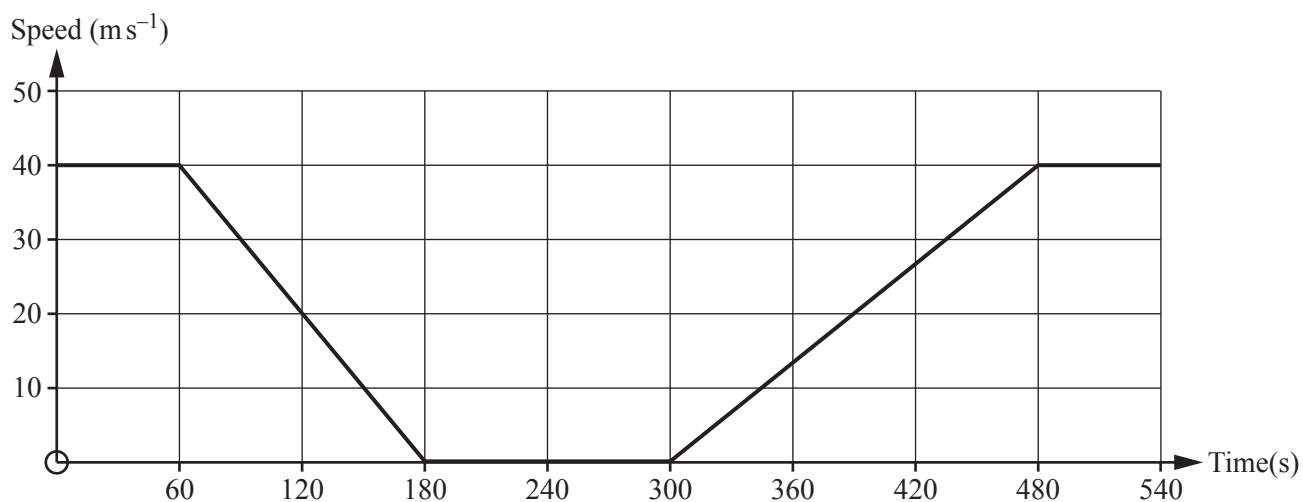
Convert this speed into miles per hour.

Comment on whether this is a realistic top speed for a train.

[You may use the fact that 5 miles is about the same as 8 km.]

[4]

|          |  |
|----------|--|
| 7(b)(ii) |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |



**Fig. 7.2 (repeated)**

**(iii)** Use the graph to calculate the acceleration of the train when it leaves the station. **[2]**

**(iv)** The distance travelled is given by the area under a speed-time graph.

Show that the distance the train travelled in the 540 seconds covered by the graph was 10.8 km.

Find also the distance the train would have travelled during this time if it had not stopped at the station but instead had maintained its speed of  $40 \text{ m s}^{-1}$ . **[3]**

|                  |  |
|------------------|--|
| <b>7(b)(iii)</b> |  |
|------------------|--|

|          |  |
|----------|--|
| 7(b)(iv) |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |
|          |  |

(v) Hence estimate the increase in the train's journey time caused by its stopping at the station.

Compare your answer with the equivalent figure for the London Paddington to Plymouth trains in part (a) of this question. [3]

|         |  |
|---------|--|
| 7(b)(v) |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |
|         |  |

**END OF QUESTION PAPER**

**ADDITIONAL ANSWER SPACE**

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



**Copyright Information**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series. If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

# OCR

Oxford Cambridge and RSA

**To be opened on receipt**

**AS GCE/Level 3 Certificate**

**QUANTITATIVE METHODS (MEI)**

**G244/01 Introduction to Quantitative Methods (IQM)**

**PRE-RELEASE MATERIAL**

**JUNE 2018**



## **NOTES FOR GUIDANCE (CANDIDATES)**

- This leaflet contains pre-release material which is needed in preparation for the examination.
- You will need to consider the materials carefully. The examination paper will contain questions related to this material. You will be expected to apply your knowledge and understanding of the work covered in G244 to answer the questions.
- You can seek advice from your teacher about the content of the material and you can discuss it with others in your class. You may also investigate the topic yourself using any resources available to you.
- For the examination, you will be given a clean copy of this pre-release material, together with a question paper. You will **not** be able to bring an annotated copy of this material, or other materials, into the examination.
- This document consists of **8** pages. Any blank pages are indicated.

## 1 Exoplanet discovery: seven Earth-sized planets spotted orbiting nearby star

*This is an extract from an article published by the Guardian on 23/02/2017. The article was written by Ian Sample, Science editor.*

A huddle of seven worlds, all close in size to Earth, and perhaps warm enough for water and the life it can sustain, has been spotted around a small, faint star in the constellation of Aquarius.

The discovery, which has thrilled astronomers, has raised hopes that the hunt for alien life beyond the solar system could start much sooner than previously thought, with the next generation of telescopes that are due to switch on in the next decade.

It is the first time that so many Earth-sized planets have been found in orbit around the same star, an unexpected haul that suggests the Milky Way may be teeming with worlds that, in size and firmness underfoot at least, resemble our own rocky home.

The planets closely circle a dwarf star named Trappist-1, which at 39 light years away makes the system a prime candidate to search for signs of life. Only marginally larger than Jupiter, the star shines with a feeble light about 2000 times fainter than our sun.

“The star is so small and cold that the seven planets are temperate, which means that they could have some liquid water and maybe life, by extension, on the surface,” said Michaël Gillon, an astrophysicist at the University of Liège in Belgium.

While the planets have Earth-like dimensions, their sizes ranging from 25% smaller to 10% larger, they could not be more different in other features. Most striking is how compact the planet’s orbits are. Mercury, the innermost planet in the solar system, is six times farther from the sun than the outermost seventh planet is from Trappist-1.

Any life that gained a foothold and the capacity to look up would have a remarkable view from a Trappist-1 world. From the fifth planet, considered the most habitable, the salmon-pink star would loom 10 times larger than the sun in our sky. The other planets would soar overhead as their orbits required, appearing up to twice the size of the moon as seen from Earth. “It would be a beautiful show,” said Amaury Triaud at the Institute of Astronomy at Cambridge University.

The researchers hope to know whether there is life on the planets “within a decade,” Amaury added. “I think we’ve made a crucial step in finding out if there’s life out there,” he said. “If life managed to thrive and releases gases in a similar way as on Earth, we will know.”

The planets are on such tight orbits that it takes between 1.5 and 20 days for them to whip around the star. At such proximity, most, if not all, will be “tidally locked”, meaning they show only one face to Trappist-1, just as one side of the moon always faces Earth. Some of the planets are thought to be the right temperature to host oceans of water, depending on the makeup of their atmospheres, but on others any hospitable regions may be confined to the bands that separate the light and dark sides of the planets.

Ignas Snellen, an astrophysicist at the Leiden Observatory in the Netherlands who was not involved in the study, said the findings show that Earth-like planets must be extremely common. “This is really something new,” he said. “When they started this search several years ago, I really thought it was a waste of time. I was very, very wrong.”

Note A light year is the distance that light travels in one year.

## 2 Crime figures for a Devon town

*This is an extract from an article in the Totnes Times on 1/2/2017.*

### Recorded crime drops in Town by 16%

Crime fell by almost 16 per cent in Totnes Town last year – in direct contrast to the rest of Devon where the crime rate rose by almost 6 per cent.

Violence, sexual offences, burglary, shoplifting, general theft, criminal damage and public order offences were all down in 2016 compared to the previous year, the latest crime figures have revealed.

The trend for Totnes town area was also in contrast to two rural and urban areas around the town which saw the level of recorded crime shoot up by more than 20 percent and by almost 15%.

The policing area for Totnes is divided into three areas – Totnes Town and two huge swathes of rural South Hams called Totnes East and Totnes West.

| Crime Group             | Totnes East    |            |              | Totnes West    |            |              | Totnes Town    |            |               |
|-------------------------|----------------|------------|--------------|----------------|------------|--------------|----------------|------------|---------------|
|                         | Recorded Crime |            |              | Recorded Crime |            |              | Recorded Crime |            |               |
|                         | 2015           | 2016       | Difference   | 2015           | 2016       | Difference   | 2015           | 2016       | Difference    |
| Violence with injury    | 20             | 18         | -10.0%       | 25             | 25         | 0.0%         | 49             | 45         | -8.2%         |
| Violence without injury | 28             | 34         | 21.4%        | 24             | 29         | 20.8%        | 48             | 38         | -20.8%        |
| Rape                    | 4              | 2          | -50.0%       | 4              | 7          | 75.0%        | 5              | 6          | 20.0%         |
| Other Sexual Offences   | 8              | 5          | -37.5%       | 3              | 11         | 266.7%       | 7              | 6          | -14.3%        |
| Robbery                 | -              | -          | -            | 0              | 2          | -            | 2              | 2          | 0.0%          |
| Burglary Dwelling       | 10             | 13         | 30.0%        | 6              | 8          | 33.3%        | 20             | 4          | -80.0%        |
| Burglary Non-Dwelling   | 16             | 18         | 12.5%        | 27             | 24         | -11.1%       | 12             | 21         | 75.0%         |
| Vehicle Offences        | 21             | 27         | 28.6%        | 14             | 7          | -50.0%       | 16             | 17         | 6.3%          |
| Shoplifting             | 2              | 3          | 50.0%        | 5              | 9          | 80.0%        | 36             | 34         | -5.6%         |
| Other Theft             | 27             | 47         | 74.1%        | 41             | 52         | 26.8%        | 83             | 59         | -28.9%        |
| Criminal Damage         | 27             | 46         | 70.4%        | 47             | 46         | -2.1%        | 62             | 52         | -16.1%        |
| Public Order Offences   | 20             | 10         | -50.0%       | 9              | 11         | 22.2%        | 28             | 21         | -25.0%        |
| Possession of Weapons   | 0              | 1          | -            | -              | -          | -            | 3              | 1          | -66.7%        |
| Trafficking of Drugs    | 1              | 4          | 300.0%       | 0              | 4          | -            | 3              | 3          | 0.0%          |
| Possession of Drugs     | 10             | 7          | -30.0%       | 7              | 8          | 14.3%        | 17             | 21         | 23.5%         |
| Other Offences          | 2              | 2          | 0.0%         | 6              | 7          | 16.7%        | 5              | 3          | -40.0%        |
| <b>Total</b>            | <b>196</b>     | <b>237</b> | <b>20.9%</b> | <b>218</b>     | <b>250</b> | <b>14.7%</b> | <b>396</b>     | <b>333</b> | <b>-15.9%</b> |

### 3 Lightning strike

*The information and data for this article were provided by Professor D.M. Elsom of Oxford Brookes University and Tornado and Storm Research Organisation (TORRO).*

Thunderstorms occur throughout the world. Usually there are electrical discharges between clouds and the earth (cloud to ground lightning) or between clouds (cloud to cloud lightning). We hear the sound made by the discharges as thunder. The term *lightning strike* is widely used to describe a discharge between the atmosphere and an object on the ground. Cloud to ground lightning may also hit an aircraft before going on to strike the ground.

Lightning strikes present a danger to animals and humans; in 2016 a storm killed 323 wild reindeer in central Norway. Estimates of human fatalities around the world vary from 6000 to 24 000 people per year; many more are injured.

In contrast to many parts of the world, historical records of cause of death in the UK allow the number of people dying from lightning strike to be known reasonably accurately and these are summarised in Table 1. The final column shows that a very high percentage of the victims were male.

| Location        | Period      | Average fatalities/year | % male |
|-----------------|-------------|-------------------------|--------|
| England & Wales | 1852 – 1899 | 19                      | 82     |
| England & Wales | 1900 – 1949 | 13                      | 89     |
| England & Wales | 1950 – 1999 | 5                       | 84     |
| UK              | 1988 – 2012 | 2                       | 83     |

**Table 1**

The format of the information in the final row of Table 1 is different from that in the other rows. The reason for this is that it is taken from a particular study covering 453 known incidents of lightning strike in the UK, involving 722 people over a 25 year period<sup>1, 2</sup>. (Some incidents involved more than one person experiencing an electrical shock.) The number of deaths was 47. This study forms the basis for the figures in the remainder of this article.

Table 1 covers deaths from lightning strike but it is only a minority of those suffering from lightning strike who die. Most recover although some have serious and long-term injuries. The immediate effects are summarised in Table 2. The figures refer to the most serious medical effect of any incident.

| Medical effects              | Outdoors | Indoors |
|------------------------------|----------|---------|
| Death                        | 21%      | 0%      |
| Recovery after resuscitation | 7%       | 0%      |
| Serious burns                | 16%      | 2%      |
| Lesser injuries              | 56%      | 98%     |
|                              | 100%     | 100%    |

**Table 2**

Table 2 distinguishes between incidents occurring outdoors and indoors. In the study 52% of incidents were outdoors, 47% indoors and 1% inside a car or an aircraft. Of those involved in outdoor incidents, 73% were male; for indoor incidents the figure was 49%.



Tables 3 and 4 give more detailed information about the percentages of incidents at different categories of location, outdoor and indoor.

| <b>Outdoors</b>                   |          |
|-----------------------------------|----------|
| <b>Category</b>                   | <b>%</b> |
| Near or under a tree              | 16       |
| Mountain, hill, moor, cliff top   | 11       |
| Low lying farmland or country     | 5        |
| Golf course                       | 13       |
| Other sports or recreation ground | 20       |
| Urban setting                     | 20       |
| Near, in or on water              | 11       |
| Other (eg airfield)               | 4        |
|                                   | 100      |

**Table 3**

| <b>Indoors</b>                     |          |
|------------------------------------|----------|
| <b>Category (near or touching)</b> | <b>%</b> |
| Corded telephone                   | 26       |
| Computer equipment                 | 5        |
| Other electrical equipment         | 13       |
| Window or external door            | 15       |
| Large object with metal pipes      | 15       |
| Other (eg in bed) or unknown       | 25       |
|                                    | 100      |

**Table 4**

Most incidents of lightning strike occur during the summer months and this is shown in Table 5.

| <b>Month</b> | <b>Incidents</b> | <b>Fatalities</b> |
|--------------|------------------|-------------------|
| January      | 2%               | 0%                |
| February     | 1%               | 0%                |
| March        | 0%               | 0%                |
| April        | 4%               | 11%               |
| May          | 14%              | 21%               |
| June         | 19%              | 17%               |
| July         | 25%              | 15%               |
| August       | 19%              | 26%               |
| September    | 8%               | 8%                |
| October      | 5%               | 2%                |
| November     | 2%               | 0%                |
| December     | 1%               | 0%                |
|              | 100%             | 100%              |

**Table 5**

1. Professor D.M. Elsom, Oxford Brookes University and Tornado and Storm Research Organisation (TORRO)
2. J.D.C. Webb, TORRO.

# OCR

Oxford Cambridge and RSA

**Wednesday 6 June 2018 – Morning**

**AS GCE/Level 3 Certificate**

**QUANTITATIVE METHODS (MEI)**

**G244/01 Introduction to Quantitative Methods (IQM)**

**Insert**

**Duration:** 1 hour 30 minutes



## **INFORMATION FOR CANDIDATES**

- This Insert contains a copy of the pre-release material for use with the Question Paper.
- This document consists of **8** pages. Any blank pages are indicated.

## **INSTRUCTION TO EXAMS OFFICER/INVIGILATOR**

- Do not send this Insert for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

## 1 Exoplanet discovery: seven Earth-sized planets spotted orbiting nearby star

*This is an extract from an article published by the Guardian on 23/02/2017. The article was written by Ian Sample, Science editor.*

A huddle of seven worlds, all close in size to Earth, and perhaps warm enough for water and the life it can sustain, has been spotted around a small, faint star in the constellation of Aquarius.

The discovery, which has thrilled astronomers, has raised hopes that the hunt for alien life beyond the solar system could start much sooner than previously thought, with the next generation of telescopes that are due to switch on in the next decade.

It is the first time that so many Earth-sized planets have been found in orbit around the same star, an unexpected haul that suggests the Milky Way may be teeming with worlds that, in size and firmness underfoot at least, resemble our own rocky home.

The planets closely circle a dwarf star named Trappist-1, which at 39 light years away makes the system a prime candidate to search for signs of life. Only marginally larger than Jupiter, the star shines with a feeble light about 2000 times fainter than our sun.

“The star is so small and cold that the seven planets are temperate, which means that they could have some liquid water and maybe life, by extension, on the surface,” said Michaël Gillon, an astrophysicist at the University of Liège in Belgium.

While the planets have Earth-like dimensions, their sizes ranging from 25% smaller to 10% larger, they could not be more different in other features. Most striking is how compact the planet’s orbits are. Mercury, the innermost planet in the solar system, is six times farther from the sun than the outermost seventh planet is from Trappist-1.

Any life that gained a foothold and the capacity to look up would have a remarkable view from a Trappist-1 world. From the fifth planet, considered the most habitable, the salmon-pink star would loom 10 times larger than the sun in our sky. The other planets would soar overhead as their orbits required, appearing up to twice the size of the moon as seen from Earth. “It would be a beautiful show,” said Amaury Triaud at the Institute of Astronomy at Cambridge University.

The researchers hope to know whether there is life on the planets “within a decade,” Amaury added. “I think we’ve made a crucial step in finding out if there’s life out there,” he said. “If life managed to thrive and releases gases in a similar way as on Earth, we will know.”

The planets are on such tight orbits that it takes between 1.5 and 20 days for them to whip around the star. At such proximity, most, if not all, will be “tidally locked”, meaning they show only one face to Trappist-1, just as one side of the moon always faces Earth. Some of the planets are thought to be the right temperature to host oceans of water, depending on the makeup of their atmospheres, but on others any hospitable regions may be confined to the bands that separate the light and dark sides of the planets.

Ignas Snellen, an astrophysicist at the Leiden Observatory in the Netherlands who was not involved in the study, said the findings show that Earth-like planets must be extremely common. “This is really something new,” he said. “When they started this search several years ago, I really thought it was a waste of time. I was very, very wrong.”

Note A light year is the distance that light travels in one year.

## 2 Crime figures for a Devon town

*This is an extract from an article in the Totnes Times on 1/2/2017.*

### Recorded crime drops in Town by 16%

Crime fell by almost 16 per cent in Totnes Town last year – in direct contrast to the rest of Devon where the crime rate rose by almost 6 per cent.

Violence, sexual offences, burglary, shoplifting, general theft, criminal damage and public order offences were all down in 2016 compared to the previous year, the latest crime figures have revealed.

The trend for Totnes town area was also in contrast to two rural and urban areas around the town which saw the level of recorded crime shoot up by more than 20 percent and by almost 15%.

The policing area for Totnes is divided into three areas – Totnes Town and two huge swathes of rural South Hams called Totnes East and Totnes West.

| Crime Group             | Totnes East    |            |              | Totnes West    |            |              | Totnes Town    |            |               |
|-------------------------|----------------|------------|--------------|----------------|------------|--------------|----------------|------------|---------------|
|                         | Recorded Crime |            |              | Recorded Crime |            |              | Recorded Crime |            |               |
|                         | 2015           | 2016       | Difference   | 2015           | 2016       | Difference   | 2015           | 2016       | Difference    |
| Violence with injury    | 20             | 18         | -10.0%       | 25             | 25         | 0.0%         | 49             | 45         | -8.2%         |
| Violence without injury | 28             | 34         | 21.4%        | 24             | 29         | 20.8%        | 48             | 38         | -20.8%        |
| Rape                    | 4              | 2          | -50.0%       | 4              | 7          | 75.0%        | 5              | 6          | 20.0%         |
| Other Sexual Offences   | 8              | 5          | -37.5%       | 3              | 11         | 266.7%       | 7              | 6          | -14.3%        |
| Robbery                 | –              | –          | –            | 0              | 2          | –            | 2              | 2          | 0.0%          |
| Burglary Dwelling       | 10             | 13         | 30.0%        | 6              | 8          | 33.3%        | 20             | 4          | -80.0%        |
| Burglary Non-Dwelling   | 16             | 18         | 12.5%        | 27             | 24         | -11.1%       | 12             | 21         | 75.0%         |
| Vehicle Offences        | 21             | 27         | 28.6%        | 14             | 7          | -50.0%       | 16             | 17         | 6.3%          |
| Shoplifting             | 2              | 3          | 50.0%        | 5              | 9          | 80.0%        | 36             | 34         | -5.6%         |
| Other Theft             | 27             | 47         | 74.1%        | 41             | 52         | 26.8%        | 83             | 59         | -28.9%        |
| Criminal Damage         | 27             | 46         | 70.4%        | 47             | 46         | -2.1%        | 62             | 52         | -16.1%        |
| Public Order Offences   | 20             | 10         | -50.0%       | 9              | 11         | 22.2%        | 28             | 21         | -25.0%        |
| Possession of Weapons   | 0              | 1          | –            | –              | –          | –            | 3              | 1          | -66.7%        |
| Trafficking of Drugs    | 1              | 4          | 300.0%       | 0              | 4          | –            | 3              | 3          | 0.0%          |
| Possession of Drugs     | 10             | 7          | -30.0%       | 7              | 8          | 14.3%        | 17             | 21         | 23.5%         |
| Other Offences          | 2              | 2          | 0.0%         | 6              | 7          | 16.7%        | 5              | 3          | -40.0%        |
| <b>Total</b>            | <b>196</b>     | <b>237</b> | <b>20.9%</b> | <b>218</b>     | <b>250</b> | <b>14.7%</b> | <b>396</b>     | <b>333</b> | <b>-15.9%</b> |

### 3 Lightning strike

*The information and data for this article were provided by Professor D.M. Elsom of Oxford Brookes University and Tornado and Storm Research Organisation (TORRO).*

Thunderstorms occur throughout the world. Usually there are electrical discharges between clouds and the earth (cloud to ground lightning) or between clouds (cloud to cloud lightning). We hear the sound made by the discharges as thunder. The term *lightning strike* is widely used to describe a discharge between the atmosphere and an object on the ground. Cloud to ground lightning may also hit an aircraft before going on to strike the ground.

Lightning strikes present a danger to animals and humans; in 2016 a storm killed 323 wild reindeer in central Norway. Estimates of human fatalities around the world vary from 6000 to 24 000 people per year; many more are injured.

In contrast to many parts of the world, historical records of cause of death in the UK allow the number of people dying from lightning strike to be known reasonably accurately and these are summarised in Table 1. The final column shows that a very high percentage of the victims were male.

| Location        | Period      | Average fatalities/year | % male |
|-----------------|-------------|-------------------------|--------|
| England & Wales | 1852 – 1899 | 19                      | 82     |
| England & Wales | 1900 – 1949 | 13                      | 89     |
| England & Wales | 1950 – 1999 | 5                       | 84     |
| UK              | 1988 – 2012 | 2                       | 83     |

**Table 1**

The format of the information in the final row of Table 1 is different from that in the other rows. The reason for this is that it is taken from a particular study covering 453 known incidents of lightning strike in the UK, involving 722 people over a 25 year period<sup>1, 2</sup>. (Some incidents involved more than one person experiencing an electrical shock.) The number of deaths was 47. This study forms the basis for the figures in the remainder of this article.

Table 1 covers deaths from lightning strike but it is only a minority of those suffering from lightning strike who die. Most recover although some have serious and long-term injuries. The immediate effects are summarised in Table 2. The figures refer to the most serious medical effect of any incident.

| Medical effects              | Outdoors | Indoors |
|------------------------------|----------|---------|
| Death                        | 21%      | 0%      |
| Recovery after resuscitation | 7%       | 0%      |
| Serious burns                | 16%      | 2%      |
| Lesser injuries              | 56%      | 98%     |
|                              | 100%     | 100%    |

**Table 2**

Table 2 distinguishes between incidents occurring outdoors and indoors. In the study 52% of incidents were outdoors, 47% indoors and 1% inside a car or an aircraft. Of those involved in outdoor incidents, 73% were male; for indoor incidents the figure was 49%.

Tables 3 and 4 give more detailed information about the percentages of incidents at different categories of location, outdoor and indoor.

| <b>Outdoors</b>                   |          |
|-----------------------------------|----------|
| <b>Category</b>                   | <b>%</b> |
| Near or under a tree              | 16       |
| Mountain, hill, moor, cliff top   | 11       |
| Low lying farmland or country     | 5        |
| Golf course                       | 13       |
| Other sports or recreation ground | 20       |
| Urban setting                     | 20       |
| Near, in or on water              | 11       |
| Other (eg airfield)               | 4        |
|                                   | 100      |

**Table 3**

| <b>Indoors</b>                     |          |
|------------------------------------|----------|
| <b>Category (near or touching)</b> | <b>%</b> |
| Corded telephone                   | 26       |
| Computer equipment                 | 5        |
| Other electrical equipment         | 13       |
| Window or external door            | 15       |
| Large object with metal pipes      | 15       |
| Other (eg in bed) or unknown       | 25       |
|                                    | 100      |

**Table 4**

Most incidents of lightning strike occur during the summer months and this is shown in Table 5.

| <b>Month</b> | <b>Incidents</b> | <b>Fatalities</b> |
|--------------|------------------|-------------------|
| January      | 2%               | 0%                |
| February     | 1%               | 0%                |
| March        | 0%               | 0%                |
| April        | 4%               | 11%               |
| May          | 14%              | 21%               |
| June         | 19%              | 17%               |
| July         | 25%              | 15%               |
| August       | 19%              | 26%               |
| September    | 8%               | 8%                |
| October      | 5%               | 2%                |
| November     | 2%               | 0%                |
| December     | 1%               | 0%                |
|              | 100%             | 100%              |

**Table 5**

1. Professor D.M. Elsom, Oxford Brookes University and Tornado and Storm Research Organisation (TORRO)
2. J.D.C. Webb, TORRO.

**GCE**

**Quantitative Methods (MEI)**

Unit **G244**: Introduction to Quantitative Methods (MEI)

Advanced Subsidiary GCE

**Mark Scheme for June 2018**

| Question |  | Answer                                                               | Marks | Guidance                                    |
|----------|--|----------------------------------------------------------------------|-------|---------------------------------------------|
| 1        |  | 39 years is $39 \times 365 \times 24$ ( $= 3.416 \times 10^5$ hours) | M1    | Converting to hours                         |
|          |  | $3.416 \times 10^5 \times 1.079 \times 10^9$                         | M1    | Multiplying by speed of light               |
|          |  | $3.686 \times 10^{14}$                                               | A1    | Power of 10 correct                         |
|          |  | $= 3.7 \times 10^{14}$ km to 2 sf                                    | A1    | CAO, must be given to 2 significant figures |
|          |  |                                                                      | [4]   |                                             |

| Question |       | Answer                                  | Marks | Guidance |
|----------|-------|-----------------------------------------|-------|----------|
| 2        | (i)   | 160                                     | B1    |          |
|          |       |                                         | [1]   |          |
|          | (ii)  | $=A19*2$                                | B1    |          |
|          |       |                                         | [1]   |          |
|          | (iii) | $2^n = 163\,840 \div 5$ ( $= 32\,768$ ) | M1    | soi      |
|          |       | $n = 15$                                | A1    |          |
|          |       | Cell is A16                             | B1    |          |
|          |       |                                         | [3]   |          |



| Question |      | Answer                                                                                             | Marks      | Guidance                      |
|----------|------|----------------------------------------------------------------------------------------------------|------------|-------------------------------|
| 3        | (i)  | Difference = $333 - 396 = -63$                                                                     | <b>B1</b>  | Allow + 63                    |
|          |      | Percentage = $\frac{-63}{396} \times 100 = -15.9\%$                                                | <b>B1</b>  | CAO                           |
|          |      | Answer rounds to (-)16% and Negative value shows it is a reduction                                 | <b>B1</b>  |                               |
|          |      |                                                                                                    | <b>[3]</b> |                               |
|          | (ii) | In Totnes town the percentage shoplifting was<br>$\frac{34}{333} \times 100$                       | <b>M1</b>  |                               |
|          |      | = 10.2%                                                                                            | <b>A1</b>  | Allow 10%                     |
|          |      | In the other two regions the figures were 1.3% and 3.6% so the rate in Totnes Town was much higher | <b>M1</b>  | Attempt at a valid comparison |
|          |      | There are more shops in the town for people to steal from.                                         | <b>A1</b>  |                               |
|          |      |                                                                                                    | <b>[4]</b> |                               |

| Question |       | Answer                                                                    | Marks | Guidance                   |
|----------|-------|---------------------------------------------------------------------------|-------|----------------------------|
| 4        | (i)   | $2 \times 10 = 20$ people over the 10 years                               | B1    |                            |
|          |       | 83% of 20 is 16.6 so 17 males and 3 females                               | B1    |                            |
|          |       |                                                                           | [2]   |                            |
|          | (ii)  | Female deaths per year are $3.4 \div 10 = 0.34$                           | M1    |                            |
|          |       | $\frac{0.34}{34\,000\,000} = \frac{1}{100\,000\,000}$ so 1 in 100 million | A1    |                            |
|          |       | For a man it is $\frac{16.6 \div 10}{33\,000\,000}$                       | B1    |                            |
|          |       | $\frac{1}{19\,879\,518}$ or 1 in 20 million                               | B1    |                            |
|          |       |                                                                           | [4]   |                            |
|          | (iii) | On average males spend more time outdoors than females                    | B1    | Or other plausible reason  |
|          |       |                                                                           | [1]   |                            |
|          | (iv)  | There were 47 deaths among 722 people                                     | B1    | Selection of suitable data |
|          |       | Estimated probability of survival $\frac{722 - 47}{722} = 0.935$ .        | B1    |                            |
|          |       |                                                                           | [2]   |                            |

| Question |       |     | Answer                                                                         | Marks | Guidance             |
|----------|-------|-----|--------------------------------------------------------------------------------|-------|----------------------|
| 5        | (i)   | (A) | It is bell-shaped                                                              | B1    |                      |
|          |       | (B) | 19 (yards)                                                                     | B1    |                      |
|          |       |     |                                                                                | [2]   |                      |
|          | (ii)  |     | 95% of the distribution lies within 2 sd of the mean                           | M1    |                      |
|          |       |     | 5% of 120 is 6, so 6 lie more than 2 sd of the mean                            | A1    |                      |
|          |       |     | Almost all lie within 3 sd of the mean                                         | B1    |                      |
|          |       |     | So the 6 lie in the intervals 16-17 and 21-22                                  |       |                      |
|          |       |     | By symmetry there are 3 in each interval.                                      | A1    |                      |
|          |       |     |                                                                                | [4]   |                      |
|          | (iii) |     | The mean is about 17 so is less than expected. (Charlie is bowling short).     | B1    | Any sensible answer. |
|          |       |     | The standard deviation is much greater. (Charlie is not bowling consistently). | B1    |                      |
|          |       |     | (The distribution is approximately Normal.)                                    |       |                      |
|          |       |     |                                                                                | [2]   |                      |

| Question |        | Answer                                                                                                                                                                                                                                                                                                                                                                           |           |        |  | Marks | Guidance                                           |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|----------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------|--|-------|----------------------------------------------------|--------|------|--------|---|----|-----|-----|-----|---|----|-----|-----|-----|----|----|-----|-----|----|----------------|--|
| 6        | (i)    | 50 people                                                                                                                                                                                                                                                                                                                                                                        |           |        |  | B1    |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        |                                                                                                                                                                                                                                                                                                                                                                                  |           |        |  | [1]   |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          | (ii)   | 10 people                                                                                                                                                                                                                                                                                                                                                                        |           |        |  | B1    |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        |                                                                                                                                                                                                                                                                                                                                                                                  |           |        |  | [1]   |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          | (iii)  | <table border="1"> <thead> <tr> <th>Price</th> <th>Attend</th> <th>Income</th> <th>Hall</th> <th>Profit</th> </tr> </thead> <tbody> <tr> <td>4</td> <td>90</td> <td>360</td> <td>120</td> <td>240</td> </tr> <tr> <td>6</td> <td>50</td> <td>300</td> <td>120</td> <td>180</td> </tr> <tr> <td>14</td> <td>10</td> <td>140</td> <td>120</td> <td>20</td> </tr> </tbody> </table> |           |        |  | Price | Attend                                             | Income | Hall | Profit | 4 | 90 | 360 | 120 | 240 | 6 | 50 | 300 | 120 | 180 | 14 | 10 | 140 | 120 | 20 | B1<br>B1<br>B1 |  |
| Price    | Attend | Income                                                                                                                                                                                                                                                                                                                                                                           | Hall      | Profit |  |       |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
| 4        | 90     | 360                                                                                                                                                                                                                                                                                                                                                                              | 120       | 240    |  |       |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
| 6        | 50     | 300                                                                                                                                                                                                                                                                                                                                                                              | 120       | 180    |  |       |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
| 14       | 10     | 140                                                                                                                                                                                                                                                                                                                                                                              | 120       | 20     |  |       |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        |                                                                                                                                                                                                                                                                                                                                                                                  |           |        |  | [3]   |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          | (iv)   | C2                                                                                                                                                                                                                                                                                                                                                                               | = A2 * B2 |        |  | B1    |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        | E6                                                                                                                                                                                                                                                                                                                                                                               | = C6 - D6 |        |  | B1    |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        |                                                                                                                                                                                                                                                                                                                                                                                  |           |        |  | [2]   |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          | (v)    | £4 for maximum profit                                                                                                                                                                                                                                                                                                                                                            |           |        |  | B1    | Accept a different answer if it is fully justified |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |
|          |        |                                                                                                                                                                                                                                                                                                                                                                                  |           |        |  | [1]   |                                                    |        |      |        |   |    |     |     |     |   |    |     |     |     |    |    |     |     |    |                |  |

| Question |      | Answer                                                    | Marks      | Guidance                                                                    |
|----------|------|-----------------------------------------------------------|------------|-----------------------------------------------------------------------------|
| 6        | (vi) | Income must be greater than £120 for there to be a profit | <b>B1</b>  |                                                                             |
|          |      | This is 40% of amount in C column so                      | <b>M1</b>  | For using 40% or equivalent.<br>May be implied by a trial and error method. |
|          |      | $\frac{40}{100} \times C = 120 \Rightarrow C = 300$       | <b>A1</b>  | Or by trial and error                                                       |
|          |      | She breaks even if the entry fee is £6                    | <b>B1</b>  | Or by trial and error                                                       |
|          |      | She makes a profit if it is £3, £4 or £5                  | <b>B1</b>  |                                                                             |
|          |      |                                                           | <b>[5]</b> |                                                                             |

| Question |     |       | Answer                                                          | Marks     | Guidance                        |
|----------|-----|-------|-----------------------------------------------------------------|-----------|---------------------------------|
| 7        | (a) | (i)   | 1803      195 minutes                                           | <b>B1</b> | One correct value               |
|          |     |       | 1945      220 minutes                                           |           |                                 |
|          |     |       | 2035      216 minutes                                           | <b>B1</b> | All three correct               |
|          |     |       |                                                                 | [2]       |                                 |
|          | (a) | (ii)  | Mark on the graph      (5, 195)                                 | <b>B1</b> | One correct point               |
|          |     |       |                                                                 | <b>B1</b> | All 3 points correct            |
|          |     |       |                                                                 |           | [2]                             |
|          |     |       | Straight line through (3, 180) and (11,220)                     | <b>B1</b> | Through any one correct point   |
|          |     |       |                                                                 | <b>B1</b> | Fully correct                   |
|          |     |       |                                                                 | [2]       |                                 |
|          | (a) | (iii) | It leaves some points on each side so it is quite good.         | <b>B1</b> | oe e.g Close fit for al points. |
|          |     |       | 165 minutes is the time that a journey would take with no stops | <b>B1</b> |                                 |
|          |     |       | 5 minutes is the extra time for each stop                       | <b>B1</b> |                                 |
|          |     |       |                                                                 | [3]       |                                 |

| Question |     |      | Answer                                              | Marks | Guidance                                 |
|----------|-----|------|-----------------------------------------------------|-------|------------------------------------------|
| 7        | (a) | (iv) | $5n = t - 165$                                      | M1    | Forming an equation with $5t$ on its own |
|          |     |      | $n = \frac{t-165}{5}$ oe                            | A1    |                                          |
|          |     |      | $t = 241 \Rightarrow n = 15.2$ so estimate 15 stops | A1    |                                          |
|          |     |      |                                                     | [3]   |                                          |

|   |     |      |                                                                              |     |                                           |
|---|-----|------|------------------------------------------------------------------------------|-----|-------------------------------------------|
| 7 | (b) | (i)  | Stationary for 2 minutes                                                     | B1  |                                           |
|   |     |      | Not at full speed for 7 minutes                                              | B1  |                                           |
|   |     |      |                                                                              | [2] |                                           |
| 7 | (b) | (ii) | $40 \text{ m s}^{-1} = 40 \times 60 \times 60 = 144\,000 \text{ m per hour}$ | M1  | Converting from seconds to hours          |
|   |     |      | $\frac{144\,000}{1000} = 144 \text{ km per hour}$                            | M1  | Converting from m to km                   |
|   |     |      | $= \frac{144}{8} \times 5 \text{ mph}$                                       | M1  | Converting from $\text{km h}^{-1}$ to mph |
|   |     |      | $= 90 \text{ mph}$ . Yes, this is a realistic speed for a train              | A1  | Both answers required                     |
|   |     |      |                                                                              | [4] |                                           |

| Question |     |       | Answer                                                                                              | Marks | Guidance |
|----------|-----|-------|-----------------------------------------------------------------------------------------------------|-------|----------|
| 7        | (b) | (iii) | Acceleration is given by the gradient                                                               | M1    |          |
|          |     |       | $= \frac{40}{180} = 0.22 \text{ ms}^{-2}$                                                           | A1    |          |
|          |     |       |                                                                                                     | [2]   |          |
| 7        | (b) | (iv)  | $40 \times 60 + \frac{1}{2} \times 40 \times 120 + \frac{1}{2} \times 40 \times 180 + 40 \times 60$ | M1    |          |
|          |     |       | 10 800 m = 10.8 km                                                                                  | A1    |          |
|          |     |       | Without stopping: $40 \times 540 = 21\,600$ m, so 21.6 km                                           | B1    |          |
|          |     |       |                                                                                                     | [3]   |          |
| 7        | (b) | (v)   | The train loses $21.6 - 10.8 = 10.8$ km                                                             | B1    |          |
|          |     |       | $\frac{10\,800}{40} = 270$ seconds = 4.5 minutes<br>So the journey time is 4½ minutes longer        | B1    |          |
|          |     |       | This is close to the 5 minutes for each stop on the Paddington to Plymouth trains.                  | B1    |          |
|          |     |       |                                                                                                     | [3]   |          |



| AS & Advanced GCE Mathematics (MEI) |    |                                                                             | Max Mark | a   | b  | c  | d  | e  | u  |   |
|-------------------------------------|----|-----------------------------------------------------------------------------|----------|-----|----|----|----|----|----|---|
| 4751                                | 01 | C1 – Introduction to advanced mathematics (AS)                              | Raw      | 72  | 60 | 55 | 50 | 45 | 40 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4752                                | 01 | C2 – Concepts for advanced mathematics (AS)                                 | Raw      | 72  | 53 | 47 | 41 | 36 | 31 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4753                                | 01 | (C3) Methods for Advanced Mathematics (A2): Written Paper                   | Raw      | 72  | 61 | 56 | 51 | 46 | 40 | 0 |
| 4753                                | 02 | (C3) Methods for Advanced Mathematics (A2): Coursework                      | Raw      | 18  | 15 | 13 | 11 | 9  | 8  | 0 |
| 4753                                | 82 | (C3) Methods for Advanced Mathematics (A2): Carried Forward Coursework Mark | Raw      | 18  | 15 | 13 | 11 | 9  | 8  | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4754                                | 01 | C4 – Applications of advanced mathematics (A2)                              | Raw      | 90  | 63 | 56 | 49 | 43 | 37 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4755                                | 01 | FP1 – Further concepts for advanced mathematics (AS)                        | Raw      | 72  | 55 | 51 | 47 | 43 | 40 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4756                                | 01 | FP2 – Further methods for advanced mathematics (A2)                         | Raw      | 72  | 48 | 42 | 36 | 31 | 26 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4757                                | 01 | FP3 – Further applications of advanced mathematics (A2)                     | Raw      | 72  | 63 | 56 | 49 | 42 | 35 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4758                                | 01 | (DE) Differential Equations (A2): Written Paper                             | Raw      | 72  | 61 | 54 | 48 | 42 | 35 | 0 |
| 4758                                | 02 | (DE) Differential Equations (A2): Coursework                                | Raw      | 18  | 15 | 13 | 11 | 9  | 8  | 0 |
| 4758                                | 82 | (DE) Differential Equations (A2): Carried Forward Coursework Mark           | Raw      | 18  | 15 | 13 | 11 | 9  | 8  | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4761                                | 01 | M1 – Mechanics 1 (AS)                                                       | Raw      | 72  | 51 | 44 | 37 | 31 | 25 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4762                                | 01 | M2 – Mechanics 2 (A2)                                                       | Raw      | 72  | 59 | 53 | 47 | 41 | 35 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4763                                | 01 | M3 – Mechanics 3 (A2)                                                       | Raw      | 72  | 61 | 54 | 48 | 42 | 36 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4764                                | 01 | M4 – Mechanics 4 (A2)                                                       | Raw      | 72  | 59 | 51 | 44 | 37 | 30 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4766                                | 01 | S1 – Statistics 1 (AS)                                                      | Raw      | 72  | 59 | 53 | 47 | 42 | 37 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4767                                | 01 | S2 – Statistics 2 (A2)                                                      | Raw      | 72  | 54 | 47 | 41 | 35 | 29 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4768                                | 01 | S3 – Statistics 3 (A2)                                                      | Raw      | 72  | 61 | 54 | 47 | 41 | 35 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4769                                | 01 | S4 – Statistics 4 (A2)                                                      | Raw      | 72  | 56 | 49 | 42 | 35 | 28 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4771                                | 01 | D1 – Decision mathematics 1 (AS)                                            | Raw      | 72  | 50 | 44 | 38 | 32 | 26 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4772                                | 01 | D2 – Decision mathematics 2 (A2)                                            | Raw      | 72  | 55 | 51 | 47 | 43 | 39 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4773                                | 01 | DC – Decision mathematics computation (A2)                                  | Raw      | 72  | 46 | 40 | 34 | 29 | 24 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4776                                | 01 | (NM) Numerical Methods (AS): Written Paper                                  | Raw      | 72  | 57 | 52 | 48 | 44 | 39 | 0 |
| 4776                                | 02 | (NM) Numerical Methods (AS): Coursework                                     | Raw      | 18  | 14 | 12 | 10 | 8  | 7  | 0 |
| 4776                                | 82 | (NM) Numerical Methods (AS): Carried Forward Coursework Mark                | Raw      | 18  | 14 | 12 | 10 | 8  | 7  | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4777                                | 01 | NC – Numerical computation (A2)                                             | Raw      | 72  | 55 | 47 | 39 | 32 | 25 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| 4798                                | 01 | FPT - Further pure mathematics with technology (A2)                         | Raw      | 72  | 57 | 49 | 41 | 33 | 26 | 0 |
|                                     |    |                                                                             | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |

| AS GCE Statistics (MEI) |    |                  | Max Mark | a   | b                     | c  | d  | e  | u  |
|-------------------------|----|------------------|----------|-----|-----------------------|----|----|----|----|
| G241                    | 01 | Statistics 1 MEI | Raw      | 72  | No entry in June 2018 |    |    |    |    |
|                         |    |                  | UMS      | 100 | 80                    | 70 | 60 | 50 | 40 |
| G242                    | 01 | Statistics 2 MEI | Raw      | 72  | No entry in June 2018 |    |    |    |    |
|                         |    |                  | UMS      | 100 | 80                    | 70 | 60 | 50 | 40 |
| G243                    | 01 | Statistics 3 MEI | Raw      | 72  | No entry in June 2018 |    |    |    |    |
|                         |    |                  | UMS      | 100 | 80                    | 70 | 60 | 50 | 40 |

| AS GCE Quantitative Methods (MEI) |    |                                                      | Max Mark | a   | b  | c  | d  | e  | u  |   |
|-----------------------------------|----|------------------------------------------------------|----------|-----|----|----|----|----|----|---|
| G244                              | 01 | Introduction to Quantitative Methods (Written Paper) | Raw      | 72  | 58 | 50 | 43 | 36 | 28 | 0 |
|                                   |    |                                                      | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| G244                              | 02 | Introduction to Quantitative Methods (Coursework)    | Raw      | 18  | 14 | 12 | 10 | 8  | 7  | 0 |
|                                   |    |                                                      | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| G245                              | 01 | Statistics 1                                         | Raw      | 72  | 61 | 55 | 49 | 43 | 37 | 0 |
|                                   |    |                                                      | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |
| G246                              | 01 | Decision Mathematics 1                               | Raw      | 72  | 50 | 44 | 38 | 32 | 26 | 0 |
|                                   |    |                                                      | UMS      | 100 | 80 | 70 | 60 | 50 | 40 | 0 |

## Level 3 Certificate, Level 3 Extended Project and FSMQ raw mark grade boundaries June 2018 series

For more information about results and grade calculations, see <https://www.ocr.org.uk/students/getting-your-results/>

### Level 3 Certificate Mathematics - Quantitative Methods (MEI)

|      |   |    |                                                                      |         |     | Max Mark | a  | b  | c  | d  | e | u |
|------|---|----|----------------------------------------------------------------------|---------|-----|----------|----|----|----|----|---|---|
| G244 | A | 01 | Introduction to Quantitative Methods with Coursework (Written Paper) | Raw     | 72  | 58       | 50 | 43 | 36 | 28 | 0 |   |
| G244 | A | 02 | Introduction to Quantitative Methods with Coursework (Coursework)    | Raw     | 18  | 14       | 12 | 10 | 8  | 7  | 0 |   |
|      |   |    |                                                                      | UMS     | 100 | 80       | 70 | 60 | 50 | 40 | 0 |   |
|      |   |    |                                                                      | Overall | 90  | 72       | 62 | 53 | 44 | 35 | 0 |   |

### Level 3 Certificate Mathematics - Quantitative Reasoning (MEI)

|                                                                                     |  |    |                                        |         |     | Max Mark | a  | b  | c  | d  | e | u |
|-------------------------------------------------------------------------------------|--|----|----------------------------------------|---------|-----|----------|----|----|----|----|---|---|
| H866                                                                                |  | 01 | Introduction to quantitative reasoning | Raw     | 72  | 56       | 49 | 42 | 35 | 28 | 0 |   |
| H866                                                                                |  | 02 | Critical maths                         | Raw     | 60  | 44       | 39 | 34 | 29 | 24 | 0 |   |
| *To create the overall boundaries, component 02 is weighted to give marks out of 72 |  |    |                                        | Overall | 144 | 109      | 96 | 83 | 70 | 57 | 0 |   |

### Level 3 Certificate Mathematics - Quantitative Problem Solving (MEI)

|                                                                                     |  |    |                                        |         |     | Max Mark | a  | b  | c  | d  | e | u |
|-------------------------------------------------------------------------------------|--|----|----------------------------------------|---------|-----|----------|----|----|----|----|---|---|
| H867                                                                                |  | 01 | Introduction to quantitative reasoning | Raw     | 72  | 56       | 49 | 42 | 35 | 28 | 0 |   |
| H867                                                                                |  | 02 | Statistical problem solving            | Raw     | 60  | 40       | 36 | 32 | 28 | 24 | 0 |   |
| *To create the overall boundaries, component 02 is weighted to give marks out of 72 |  |    |                                        | Overall | 144 | 104      | 92 | 80 | 69 | 57 | 0 |   |

### Advanced Free Standing Mathematics Qualification (FSMQ)

|      |  |    |                        |     |     | Max Mark | a  | b  | c  | d  | e | u |
|------|--|----|------------------------|-----|-----|----------|----|----|----|----|---|---|
| 6993 |  | 01 | Additional Mathematics | Raw | 100 | 56       | 50 | 44 | 38 | 33 | 0 |   |

### Intermediate Free Standing Mathematics Qualification (FSMQ)

|      |  |    |                                           |     |    | Max Mark | a  | b  | c  | d  | e | u |
|------|--|----|-------------------------------------------|-----|----|----------|----|----|----|----|---|---|
| 6989 |  | 01 | Foundations of Advanced Mathematics (MEI) | Raw | 40 | 35       | 30 | 25 | 20 | 16 | 0 |   |