



Pearson
Edexcel

Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE

In Statistics (9ST0)

Paper 01: Data and Probability

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Summer 2023

Publications Code 9ST0_01_2306_MS

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General Marking Guidance

Total marks

The total number of marks for the paper is 80.

Mark types

The Edexcel Statistics mark schemes use the following types of marks:

- **M** **Method** marks, awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** **Accuracy** marks can only be awarded if the relevant method (M) marks have been earned.
- **B** **Unconditional accuracy** marks are independent of M marks
- **E** **Explanation** marks

NOTE: Marks should not be subdivided.

Abbreviations

These are some of the marking abbreviations that will appear in the mark schemes.

- ft follow through
- PI possibly implied
- cao correct answer only
- cso correct solution only
(There must be no errors in this part of the question)
- awrt answers which round to
- awfw answers which fall within (a given range)
- SC special case
- nms no method shown
- oe or equivalent
- dep dependent (on a given mark or objective)
- dp decimal places
- sf significant figures
- * The answer is printed on the paper

Further notes

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied **positively**. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is **no ceiling** on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- All A marks are 'correct answer only' (cao), unless shown, for example, as A1ft to indicate that previous wrong working is to be followed through.
- All M marks are 'possibly implied' (PI) unless specifically stated otherwise in the 'Notes' column.
- After a **misread**, the subsequent A marks affected are treated as A1ft, but manifestly absurd answers should never be awarded A marks.
- **Crossed out** work should be marked UNLESS the candidate has replaced it with an alternative response.
- If **two solutions** are given, each should be marked, and the resultant mark should be the mean of the two marks, rounded down to the nearest integer if needed.

| Question | Scheme | Marks | AO | Notes |
|----------|---|-------|------|---|
| 1(a)(i) | <p>Advantages (not exhaustive)</p> <p>The response rate is likely to be good.</p> <p>Customers will be able to feed back as soon as the meal is finished.</p> | E1 | 3.1a | <p>Quick feedback</p> <p>Any sensible advantage</p> |
| 1(a)(ii) | <p>Disadvantages (not exhaustive)</p> <p>It will be expensive to pay a staff member to be there permanently.</p> <p>The restaurant may not have the layout to station someone at the exit.</p> <p>Only asks customers using the main exit</p> <p>Customers may not like being accosted on the way out.</p> <p>Customers may overhear and repeat each other's answers</p> | E1 | 3.1a | <p>Any sensible disadvantage</p> |

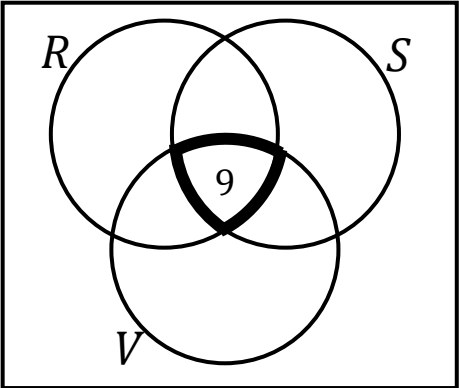
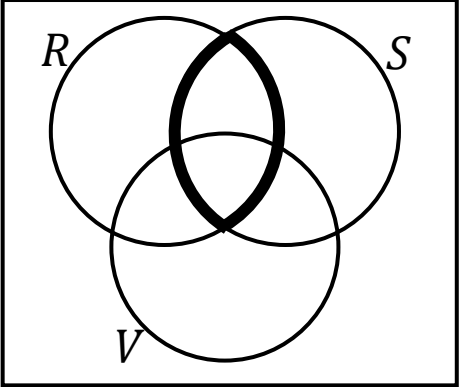
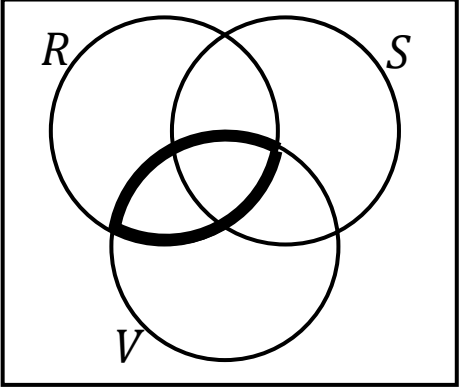
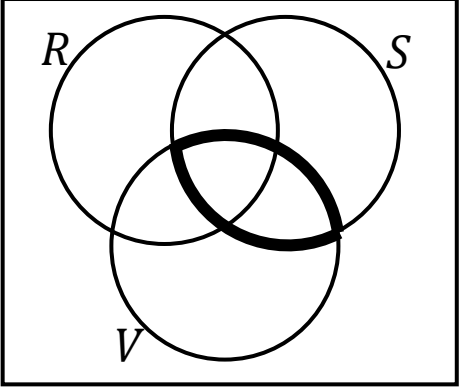
| Question | Scheme | Marks | AO | Notes |
|----------|--|-------|------|--|
| 1(b)(i) | <p>Advantages (not exhaustive)</p> <p>They are contacting everyone.</p> <p>There will be minimal ongoing costs after the initial start-up.</p> <p>Provides online data in an easy to use form</p> | E1 | 3.1a | <p>or relatively cheap</p> <p>Any sensible advantage</p> |
| 1(b)(ii) | <p>Disadvantages (not exhaustive)</p> <p>The response rate is likely to be low.</p> <p>Lots of customers do not take receipts away.</p> <p>Lots of customers do not look at the back of receipts.</p> <p>Customers may not have access to the internet</p> <p>Only the person who pays will have the receipt and therefore the survey</p> | E1 | 3.1a | <p>oe</p> <p>Any sensible disadvantage</p> |

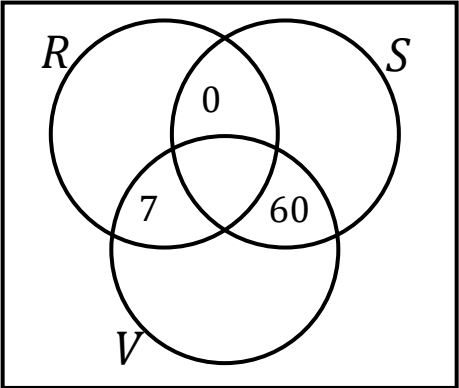
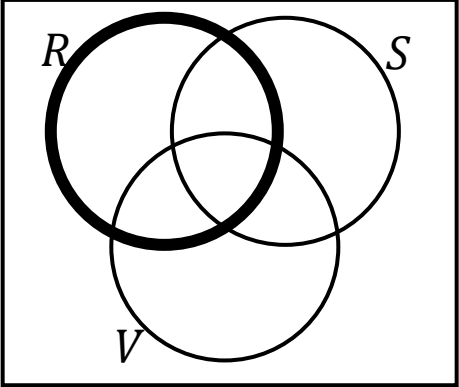
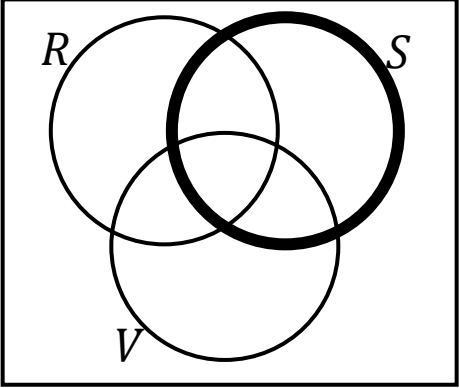
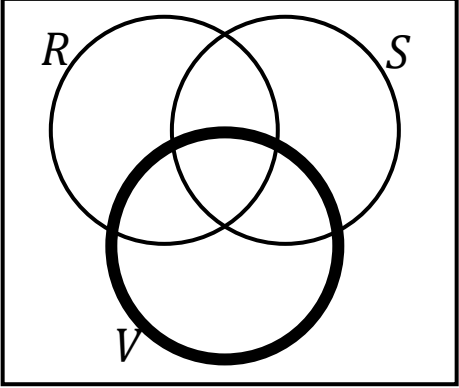
| Question | Scheme | Marks | AO | Notes |
|------------------------|---|-----------|-------------|--|
| <p>1(c)(i)</p> | <p>Advantages (not exhaustive)</p> <p>The company may be able to contact the customers in the future for feedback or marketing purposes.</p> <p>Quick to get the survey out.</p> <p>Very cheap.</p> <p>Easy to set up.</p> <p>Provides online data in an easy to use form</p> | <p>E1</p> | <p>3.1a</p> | <p>Any sensible advantage</p> |
| <p>1(c)(ii)</p> | <p>Disadvantages (not exhaustive)</p> <p>Lots of customers may not want to give their email addresses.</p> <p>Asking for email addresses may make customers unhappy.</p> <p>There may be data protection issues.</p> <p>It will take longer to take orders in the restaurant.</p> <p>Only the person who pays will have the receipt and therefore the survey</p> | <p>E1</p> | <p>3.1a</p> | <p>or GDPR oe</p> <p>Any sensible disadvantage</p> |

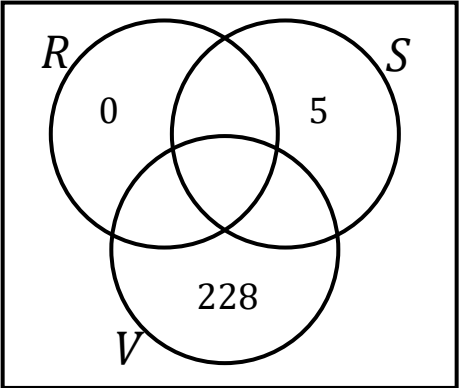
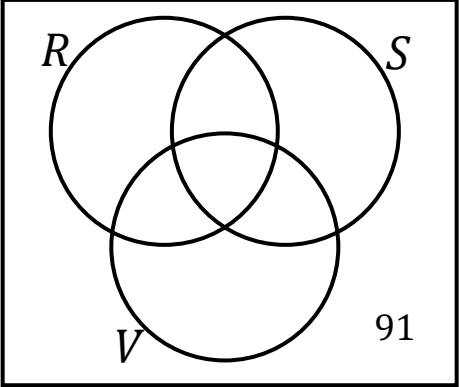
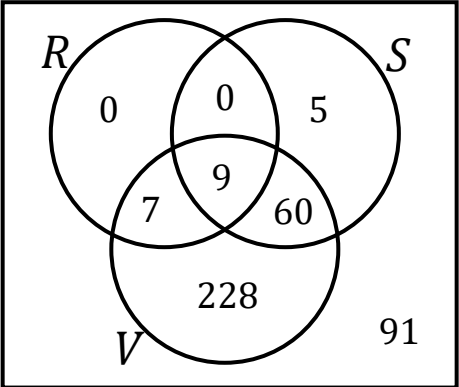
| Question | Scheme | Marks | AO | Notes |
|----------|---|-------|------|--|
| 1(d) | <p>Method 2, as it is both cheap and inconvenient to customers as you aren't asked for your email address</p> <p>Method 3, is cheap, and not inconvenient to customers as you can't lose your receipt</p> | E1 | 2.1b | <p>Method 2 or 3 must be chosen as these minimise expense, and a comment must also be made about inconvenience</p> |

| Question | Scheme | Marks | AO | Notes |
|--------------|--|----------|------------|--|
| 1(e) | <p>Possible suggestions (not exhaustive)</p> <p>Offer some free food if people take the survey.</p> <p>Enter survey-takers into a prize draw.</p> <p>Make sure the survey is clear and concise.</p> <p>Tell customers that the survey will only take 2 minutes.</p> <p>Send survey multiple times</p> | E1, E1 | 3.1a, 3.1a | <p>E1 for each sensible suggestion (max E2)</p> <p>Not dep on (d)</p> |
| Total | | 9 | | |

| Question | Scheme | Marks | AO | Notes |
|--------------|---|-------------------|---------------------------------|---|
| 2(a) | 33% | B1 | 1.1 | awfw 30~35% |
| 2(b) | 3 | B1 | 1.1 | |
| 2(c) | The nations could be colour-coded. A key could be added | E1 | 1.1 | Any sensible suggestion |
| 2(d) | <p>Possible criticisms (not exhaustive)</p> <p>There is no key/legend (rather than having nation labels on the graph).</p> <p>No consistent labelling on time (<i>x</i>) axis (e.g., every other Olympics).</p> <p>No label on (<i>x</i>) axis.</p> <p>No label on (<i>y</i>) axis</p> <p>There is no line for the proportion (<i>y</i>) axis.</p> <p>No (<i>y</i>) axis on the left side.</p> <p>Use of †‡* symbols with no explanation</p> <p>No source</p> <p>y-axis goes</p> | E1, E1, E1, E1 | 3.1a, 3.1a, 3.1a, 3.1a | E1 for each sensible criticism (max E4) |
| Total | | 7 | | |

| Question | Scheme | Marks | AO | Notes |
|----------|---|-------|-----|------------------------------|
| 3(a) |  | B1 | 1.1 | cao |
| |  | | | Cells add to 9 |
| |  | M1 | 1.1 | or Cells add to 16 |
| |  | | | or Cells add to 69 |

| Question | Scheme | Marks | AO | Notes |
|----------|---|-------|-----|------------------------|
| |  | A1 | 1.1 | All three correct |
| |  | M1 | 1.1 | Cells add to 16 |
| |  | | | or Cells add to 74 |
| |  | | | or Cells add to 304 |

| Question | Scheme | Marks | AO | Notes |
|----------|---|-------|-----|--|
| |  | A1 | 1.1 | All three correct |
| |  | B1 | 1.1 | cao |
| |  | | | Fully correct diagram [scores full marks] |

| Question | Scheme | Marks | AO | Notes |
|-----------|--|-------|-----|---|
| | SC | | | Scores max B1M1A0M1A0B0 Remove 1 mark for each small slip |
| 3(b)(i) | $P(R) = \frac{16}{400} = \frac{1}{25} = 0.04$ | B1 | 1.2 | Any of these, oe Condone SC $\frac{50}{400} = \frac{1}{8} = 0.125$ or $\frac{50}{897} = 0.0557$ |
| 3(b)(ii) | $P(S' \cap V)$ | M1 | 1.2 | PI $P(S' \cap V)$ or correct numerator seen Condone SC $16 + 304$ |
| | $= \frac{7 + 228}{400}$ | | | |
| | $= \frac{235}{400} = \frac{47}{80} = 0.588 \text{ (3sf)}$ | A1 | 1.2 | awfw 0.587~0.588 Condone SC $\frac{320}{400} = \frac{4}{5} = 0.8$ or $\frac{320}{897} = 0.357$ |
| 3(b)(iii) | $P(R' \cap S' \cap V')$ $= \frac{91}{400} = 0.228 \text{ (3sf)}$ | B1 | 1.2 | awfw 0.227~0.228 Condone SC $\frac{400}{897} = 0.446$ |

| Question | Scheme | Marks | AO | Notes |
|----------|---|--------|------|--|
| 3(b)(iv) | P(R S) | | | |
| | $= \frac{9}{74} = 0.122$ (3sf) | M1 | 1.2 | PI Numerator or denominator correct or correct use of $P(R S) = \frac{P(R \cap S)}{P(S)}$ |
| | | A1 | 1.2 | Fully correct Condone SC $\frac{18}{161} = 0.112$ |
| 3(c) | P(R) = 0.04 P(R S) = 0.122 | M1 | 2.1b | PI oe P(R) and P(R S) considered |
| | P(R) ≠ P(R S) so R and S are not statistically independent. | A1 | 2.1b | Correct comparison and conclusion. |
| | Alternative | | | |
| | $P(S) = \frac{74}{400} = \frac{37}{200} = 0.185$ | (M1) | | PI Attempt at finding P(R ∩ S) and P(R) × P(S) |
| | $P(R \cap S) = \frac{9}{400} = 0.0225$ | | | |
| | $P(R) \times P(S) = \frac{37}{5000} = 0.0074$ | | | |
| | P(R) × P(S) ≠ P(R ∩ S) so R and S are not statistically independent. | (A1ft) | | Correct comparison and conclusion. Dep on correct calculations in M1 ft their (a) and (b)(i) |

| Question | Scheme | Marks | AO | Notes |
|--------------|--|-----------|------|---|
| 3(d) | Possible reasons (not exhaustive) | | | |
| | Larger screens have more space for pixels. | | | |
| | More pixels need a larger screen to fit. | | | |
| | More expensive televisions are more likely to have bigger screens and higher resolution. | | | |
| | | E1 | 2.1a | Any sensible reason linking higher resolution and larger screen |
| Total | | 15 | | |

| Question | Scheme | Marks | AO | Notes |
|-----------------|--|-------|-----|--|
| 4(a) | $x = \frac{1}{15}$ | B1 | 1.1 | or awrt 0.067 |
| 4(b)(i) | $P(X > 10)$ | | | |
| | $= P(10 < X < 15)$ | | | |
| | $= 5 \times \frac{1}{15} = \frac{1}{3}$ | B1 | 1.1 | oe or awrt 0.33 |
| 4(b)(ii) | $\left(\frac{1}{3}\right)^3$ | M1 | 1.2 | PI Their (i) cubed |
| | $= \frac{1}{27}$ | A1 | 1.2 | oe or awrt 0.037 |
| 4(c)(i) | [X = Number of Zombies spawning in the next 5 seconds] | | | |
| | [X ~ Po(λ)] | | | |
| | $\lambda = 1$ | B1 | 1.2 | |
| | $P(X \geq 1) = 1 - P(X = 0)$ | M1 | 1.2 | PI |
| | $= 0.632$ (3sf) | A1 | 1.2 | awrt |
| | Alternative | | | |
| | [X = Time before next zombie spawn (seconds)] | | | |
| | [X ~ Exp(λ)] | | | |
| | $\lambda = \frac{1}{5} = 0.2$ | (B1) | | oe |
| | $P(X \leq 5) = 1 - e^{-0.2 \times 5}$ | (M1) | | PI Correct use of exponential formula or 0.368 seen Condone $\lambda = 5$ Condone one small slip |
| $= 0.632$ (3sf) | (A1) | | | |

| Question | Scheme | Marks | AO | Notes |
|------------------|--|-------|------|---|
| 4(c)(ii) | $X \sim Po(2)$ $P(X = 0)$ | M1 | 1.2 | PI |
| | $= 0.135$ (3sf) | A1 | 1.2 | awrt |
| | Alternative | | | |
| | $P(X > 10) = 1 - P(X \leq 10)$ | | | |
| | $= 1 - (1 - e^{-0.2 \times 10})$ $= e^{-0.2 \times 10}$ | (M1) | | PI |
| | $= 0.135$ (3sf) | (A1) | | |
| 4(c)(iii) | [Y = Number of zombies spawning in the next minute (60 seconds)] | | | |
| | $Y \sim Po(\lambda)$ | B1 | 2.1b | PI Poisson distribution stated or clearly used |
| | Mean: $\lambda = 60 \times 0.2 = 12$ | B1 | 1.2 | PI |
| | $P(Y \leq 10)$ | M1 | 1.2 | PI Attempt to find this probability |
| | $= 0.347$ (3sf) | A1 | 1.2 | awrt |
| 4(d) | From tables or calculator, use $\lambda = 6$ [per minute] | B1 | 1.2 | |
| 4(e) | Exponential mean = $\frac{1}{6}$ minute | B1 | 1.2 | Or equivalent in seconds |

Total 15

| Question | Scheme | | | | Marks | AO | Notes | | | |
|---|--|------|------|------|-------|------|----------------|---|------|------|
| 5(a) | Foreign Born | 1 | 2 | 2.5 | 10 | 11 | 15.5 | 18 | 24.5 | 27 |
| | English Literacy | 90.5 | 94.3 | 91.7 | 98.7 | 98.3 | 98 | 98.9 | 96.5 | 96.4 |
| | | | | | | M1 | 1.1 | PI At least one point correctly located (in both variables) Condone ± 0.1 | | |
| | | | | | | M1 | 1.1 | PI All points correctly located Condone ± 0.1 | | |
| | Printing Error | | | | | | | | | |
| <ul style="list-style-type: none"> Foreign born 18 replaced with 19 (leads to $r=0.624$) English literacy recorded as 0 for foreign born=18 (leads to $r=-0.165$) Foreign born 18 has English literacy left blank (leads to $r=0.59$) | | | | | | | | | | |
| 5(b) | $r = 0.616$ (3sf) | | | | A1 | 1.2 | awfw 0.59~0.64 | | | |
| 5(c) | Possible reasons | | | | | | | | | |
| | The data is not linear. | | | | | | | | | |
| | There appear to be two different groups. | | | | | | | | | |
| | | | | | E1 | 3.1a | | | | |

| Question | Scheme | Marks | AO | Notes |
|----------|--|-------|------|--|
| 5(d) | The same data, when considered at different levels... | E1 | 3.1b | Mention that the same data is used or Mention of different levels |
| | ...is producing both positive and negative values of r . | E1 | 3.1b | Mention of positive and negative r or Mention of extreme difference in values (oe) |

| Question | Scheme | Marks | AO | Notes |
|----------|--|-------|----|---|
| 5(e) | Foreign-born people moving to the USA are likely to move to regions with lots of urban areas (where there are more jobs). | | | Linking foreign-born with a third variable Examples Urbanness Availability of jobs Money/prosperity Better schools Nicer area Others of their nationality in area |
| | People in urban areas are generally better educated than those in rural areas. | | | Linking education (or literacy skills) with same variable or Linking education (or literacy skills) with one of above variables if first E1 not awarded |
| | So, we would expect regions with lots of foreign-born population to have a high literacy. | | | Association between foreign-born and English literacy due to a common third variable |
| | However, at an individual level, people who are foreign-born are more likely to have another language as their first language, so their English literacy is likely to be poorer. | | | Implication that English may not be first language |
| | An individual can't have a foreign born %, they are either foreign born or not | | | |
| | The grouped data is likely to have fewer outliers | | | Or anomalies |
| | Looking at individuals would have a larger sample size with more data points | | | |
| | 9 regions might not cover the whole of the USA while individual data does | | | |

| Question | Scheme | Marks | AO | Notes |
|----------|---|-------------------|---------------------------------|--|
| | Literacy rate of American born population in an area may skew figures | | | |
| | May not have data for all adults in a region | | | |
| | | E1, E1, E1, E1 | 2.1a, 2.1a, 2.1a, 2.1a | One mark per comment Not exhaustive |
| | Total | 10 | | |

| Question | Scheme | Marks | AO | Notes | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------|--|---------------------|----------------------------|--|---------|-------|---|-------|----------------------------|--|--|-------|----|-------|---|-------|----------------------------|--|--|-------|----|-------|---|-------|----------------------------|--|--|-------|----|--|--|--|
| 6(a) | <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 30%; text-align: center;">Type of asbestos</th> <th style="width: 20%;"></th> <th style="width: 20%; text-align: center;">Removal</th> </tr> </thead> <tbody> <tr> <td style="text-align: right; padding-right: 10px;">0.972</td> <td style="text-align: center; padding: 5px;">W</td> <td style="text-align: right; padding-right: 5px;">0.015</td> <td style="padding: 5px;">R (0.972 × 0.015 = 0.0146)</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right; padding-right: 5px;">0.985</td> <td style="padding: 5px;">R'</td> </tr> <tr> <td style="text-align: right; padding-right: 10px;">0.018</td> <td style="text-align: center; padding: 5px;">B</td> <td style="text-align: right; padding-right: 5px;">0.971</td> <td style="padding: 5px;">R (0.018 × 0.971 = 0.0175)</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right; padding-right: 5px;">0.029</td> <td style="padding: 5px;">R'</td> </tr> <tr> <td style="text-align: right; padding-right: 10px;">0.010</td> <td style="text-align: center; padding: 5px;">O</td> <td style="text-align: right; padding-right: 5px;">0.153</td> <td style="padding: 5px;">R (0.01 × 0.153 = 0.00153)</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right; padding-right: 5px;">0.847</td> <td style="padding: 5px;">R'</td> </tr> </tbody> </table> </div> | | Type of asbestos | | Removal | 0.972 | W | 0.015 | R (0.972 × 0.015 = 0.0146) | | | 0.985 | R' | 0.018 | B | 0.971 | R (0.018 × 0.971 = 0.0175) | | | 0.029 | R' | 0.010 | O | 0.153 | R (0.01 × 0.153 = 0.00153) | | | 0.847 | R' | | | <p>Any correct pair of conditional values given (0.015/0.985 after 0.972, 0.971/0.029 after 0.018 or 0.153/0.847 after 0.010)</p> <p>A1 1.2</p> <p>A1 1.2 Completely correct</p> |
| | Type of asbestos | | Removal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.972 | W | 0.015 | R (0.972 × 0.015 = 0.0146) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 0.985 | R' | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.018 | B | 0.971 | R (0.018 × 0.971 = 0.0175) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 0.029 | R' | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.010 | O | 0.153 | R (0.01 × 0.153 = 0.00153) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 0.847 | R' | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6(b) | $0.972 \times 0.015 + 0.018 \times 0.971 + 0.01 \times 0.153$ $= 0.033588$ | <p>M1</p> <p>A1</p> | | <p>Or 0.0146 + 0.0175 + 0.00153</p> <p>May be seen on diagram</p> <p>Allow one small slip</p> <p>awrt 0.0336</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Question | Scheme | Marks | AO | Notes |
|--------------|---|-----------|------|---|
| 6(c) | $P(B R) = \frac{P(B \cap R)}{P(R)}$ $= \frac{0.018 \times 0.971}{0.972 \times 0.015 + 0.018 \times 0.971 + 0.01 \times 0.153}$ $= 0.520 \text{ (3sf)}$ | B1 | 1.2 | |
| | | B1 | 1.2 | Numerator correct or awrt 0.0175 seen anywhere (including on tree diagram) |
| | | B1 | 1.2 | Denominator correct or is 'their (b)' |
| | | A1 | 1.2 | awfw 0.52~0.55 |
| 6(d) | <p>Possible reasons (not exhaustive)</p> <p>Blue asbestos may be easier to remove (so it is removed more often).</p> <p>Blue asbestos may be more dangerous (so it is removed more often).</p> | E1 | 2.1a | Any sensible reason |
| 6(e) | <p>No, I disagree with Riddhi's statement...</p> <p>...as about 52% of the company's removals are of blue asbestos...</p> <p>...so lots of safety equipment for blue asbestos will be required.</p> | E1dep | 3.1b | dep on good attempt at explanation ft their (a) |
| | | E1ft | 3.1b | Reference to 0.520 ft their (a) |
| | | E1 | 3.1b | Relating back to safety equipment correctly. |
| Total | | 12 | | |

| Question | Scheme | Marks | AO | Notes |
|-----------------|--|----------------------------|------------------------------|--|
| 7(a) | $\mu \approx 0.971$ The normal distribution is symmetrical, so the mean equals the median. | B1 E1 | 2.1b 2.1b | |
| 7(b) | Approximately $\frac{2}{3}$ of data lies within $\mu \pm \sigma \dots$...so $\mu + \sigma = S_5$ $\sigma \approx 1.000 - 0.971$ $= 0.029$ SC $1.000 - 0.971 = 0.029$ or $0.971 - 0.942 = 0.029$ seen with no explanation scores E0M1A0 | E1 M1 A1*dep | 2.1b 2.1b 2.1b | oe PI oe for example $\mu - \sigma = S_1$ or $0.971 - 0.942$ dep on E1 |
| 7(c)(i) | $[M = 2D:4D \text{ ratio of a randomly selected male adult}]$ $[M \sim N(0.952, 0.034^2)]$ $P(M > 1) = 0.0790$ (3sf) | B1 | 1.2 | awrt 0.079 |
| 7(c)(ii) | $P(0.9 < M < 1) = 0.858$ (3sf) | B1 | 1.2 | awrt 0.86 |

| Question | Scheme | Marks | AO | Notes |
|--------------|--|---|--|--|
| 7(d) | <p>[$F = 2D:4D$ ratio of a randomly selected female adult]</p> <p>[$F \sim N(0.971, 0.029^2)$]</p> <p>[$D =$ Difference between 2D:4D ratio of a randomly selected male and female adult]</p> <p>$D = F - M$</p> <p>$D \sim N(0.019, 0.0447^2)$</p> <p>$P(D > 0) = 0.665$ (3sf)</p> | <p>M1</p> <p>M1</p> <p>B1</p> <p>B1</p> <p>A1</p> | <p>2.1b</p> <p>2.1b</p> <p>1.2</p> <p>1.2</p> <p>1.2</p> | <p>PI</p> <p>or</p> <p>$D = M - F$</p> <p>PI</p> <p>Normal distribution used for difference</p> <p>PI</p> <p>$\mu = \pm 0.019$</p> <p>cao</p> <p>PI</p> <p>$\sigma = 0.0447$ (awrt)</p> <p>or</p> <p>$\sigma^2 = 0.00200$ (awrt)</p> <p>awfw 0.664~0.665</p> |
| Total | | 12 | | |

