Pearson Edexcel

**GCE AS Further Mathematics (8FM0) – Shadow Paper (Set 1)**
**8FM0-23 Further Statistics 1**

**October 2020 Shadow Paper mark scheme**

**Please note that this mark scheme is not the one used by examiners for making scripts. It is intended more as a guide, indicating where marks are given for correct answers. As such, it may not show follow-through marks (marks that are awarded despite errors being made) or special cases.**

**It should also be noted that for many questions, there may be alternative methods of finding correct solutions that are not shown here – they will be covered in the formal mark scheme from the original paper.**

**This document is intended for guidance only and may differ significantly from the examiners' final mark scheme for the original paper which was published in December 2020.**

| **Guidance on the use of codes within this document** |
| --- |
| M1 – method mark. This mark is generally given for an appropriate method in the context of the question. This mark is given for showing your working and may be awarded even if working is incorrect.<br><br>A1 – accuracy mark. This mark is generally given for a correct answer following correct working.<br><br>B1 – working mark. This mark is usually given when working and the answer cannot easily be separated.<br><br>Some questions require all working to be shown; in such questions, no marks will be given for an answer with no working (even if it is a correct answer). |

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **1(a)** | $X \sim$ Po(6.4) | M1 | 3.4 |
| | P($X$ = 8) = 0.11599… awrt **0.116** | A1 | 1.1b |
| | | **(2)** | |
| **(b)** | $Y \sim$ Po(25.6) | M1 | 3.3 |
| | [P($Y$ > 35) =] 1 – P($Y \leq$ 35) = 1 – 0.9698…= 0.0302…. **0.03** | A1* | 1.1b |
| | | **(2)** | |
| **(c)(i)** | [50 × 0.0302] awrt **1.51** | B1 | 1.1b |
| | | **(1)** | |
| **(ii)** | $\sqrt{50(0.0302)(1-0.0302)}$ | M1 | 1.1b |
| | = 1.2101…. awrt **1.2** | A1 | 1.1b |
| | | **(2)** | |
| **(iii)** | B(50, 0.0302) → Po(1.51) | M1 | 3.4 |
| | P($W \geq$ 7) = 1 – P($W \leq$ 6) [ = 1 – 0.9990…] | M1 | 1.1b |
| | = 0.001… awrt **0.001** | A1 | 1.1b |
| | | **(3)** | |
| | | | **(10 marks)** |

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **2(a)** | $H_0$: There is no association between the hand and the number of heads | B1 | 2.5 |

| | | | |
|---|---|---|---|
| | $H_1$: There is an association between the hand and the number of heads | | |
| | <table><tr><th></th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th></tr><tr><td>E</td><td>$\frac{80\times25}{160}$ = 12.5</td><td>$\frac{80\times31}{160}$ = 15.5</td><td>$\frac{80\times42}{160}$ = 21</td><td>$\frac{80\times26}{160}$ = 13</td><td>$\frac{80\times36}{160}$ = 18</td></tr></table> | M1<br>A1 | 1.1b<br>1.1b |
| | $\chi^2 = \sum\frac{(O-E)^2}{E} = \frac{(9-10)^2}{10} + \frac{(11-10)^2}{10} + \ldots + \frac{(24-28)^2}{28}$ | M1 | 1.1b |
| | = 1.5794068…… awrt **1.58** | A1 | 1.1b |
| | Degrees of freedom [= (5 – 1) × (2 – 1)] = 4<br>$\chi^2_{4,0.10} = 7.779$ | M1 | 3.1b |
| | (Do not reject $H_0$.) There is not enough evidence to suggest an association between the hand flipping the coin and the number of heads. | A1 | 2.2b |
| | | **(7)** | |
| **(b)** | B(4, 0.5) | B1 | 3.3 |
| | | **(1)** | |
| **(c)** | $H_0$: B(4, 0.5) is a suitable model<br>$H_1$: B(4, 0.5) is not a suitable model | B1ft | 3.4 |
| | <table><tr><th></th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th></tr><tr><td>E</td><td>160×P($X$ = 0) = 10</td><td>160×P($X$ = 1) = 40</td><td>160×P($X$ = 2) = 60</td><td>160×P($X$ = 3) = 40</td><td>160×P($X$ = 4) = 10</td></tr></table> | M1<br>A1 | 2.1<br>1.1b |
| | $\chi^2 = \sum\frac{(O-E)^2}{E} = \frac{(25-10)^2}{10} + \frac{(31-40)^2}{40} + \frac{(42-60)^2}{60} + \frac{(26-40)^2}{40} + \frac{(36-10)^2}{10}$ | M1 | 1.1b |
| | = 102.425 awrt **102** | A1 | 1.1b |
| | [df = 4] $\chi^2_{4,0.05} = 9.488$ | M1 | 3.1b |
| | (Reject $H_0$) B(4, 0.5) is not a suitable model for the number of heads. | A1 | 3.5a |
| | | | |

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| 3 | $\Sigma p = 1 \rightarrow k + \frac{k}{3} + \frac{k}{6} + \frac{m}{6} + \frac{m}{12} = 1$<br>$\Sigma px = 2.6 \rightarrow k + \frac{k}{3}(3) + \frac{k}{6}(6) + \frac{m}{6}(2) + \frac{m}{12}(4) = 2.6$ | M1 | 3.1a |
| | $\frac{9k}{6} + \frac{m}{4} = 1\ [= 6k + m = 4]$ | A1 | 1.1b |
| | $3k + \frac{2m}{3} = 2.6$ | A1 | 1.1b |
| | Solving simultaneously to eliminate one variable | dM1 | 1.1b |
| | $k = \frac{1}{15}$ and $m = \frac{18}{5}$ | A1 | 1.1b |
| | $E(X^2) = 1^2 \times k + 3^2 \times \frac{k}{3} + 6^2 \times \frac{k}{6} + 2^2 \times \frac{m}{6} + 4^2 \times \frac{m}{12} [= \frac{118}{15}]$ | M1 | 1.1b |
| | $\text{Var}(X) = \frac{118}{15} - 2.6^2$ | | |
| | = **1.11 or $\frac{83}{75}$** | A1 | 1.1b |
| | | | **(7 marks)** |

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **4(a)** | [$X$ ~ Po(6) $Y$ ~ Po(2)]<br>[$X + Y$ ~] Po (8) | B1 | 3.3 |
| | The number of cyclists travelling eastbound is independent of the number of cyclists travelling westbound. | B1 | 3.5b |
| | | **(2)** | |
| **(b)** | $\dfrac{P(X = 10) \times P(Y = 1) + P(X = 11) \times P(Y = 0)}{P(X + Y = 11)}$ | M1<br>M1 | 2.1<br>1.1b |
| | = 0.1970837… awrt **0.197** | A1 | 1.1b |
| | | **(3)** | |
| **(c)** | $H_0$: $\lambda = 8$ or $\mu = 24$<br>$H_1$: $\lambda < 8$ or $\mu < 24$ | B1 | 2.5 |
| | ($E + W$) ~ Po(24) P($E + W \leq 17$) [= awrt 0.087] | M1 | 3.3 |
| | (Reject $H_0$.) There is evidence that the **rate**(oe) of **cyclists**(oe) has decreased. | A1 | 2.2b |
| | | **(3)** | |

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom