# Mark Scheme (Results)

## October 2021

### Pearson Edexcel International A Level
### In Statistics S2 (WST02) Paper 01

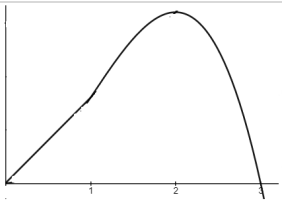
| Question Number | Scheme | Marks |
|---|---|---|
| **Throughout the paper the candidates may use different letters to the ones given in the mark scheme.** | | |
| 1(a) | $P(F \leq 12) = 1 - P(F, 11)$ | M1 |
| | = 0.34517… awrt 0.345 | A1 |
| | | (2) |
| (b) | $P(8, F < 15) = P(F, 14) - P(F, 7)$ | M1 |
| | =0.81104… awrt 0.811 | A1 |
| | | (2) |
| (c) | $3(30 - F) + F < 70$ or $F > 10$ ; $3(R) + 30 - R < 70$ or $R < 20$ | M1 |
| | $P(F > 10) = 1 - P(F, 10)$ ; $P(R < 20) = P(R, 19)$ | M1 |
| | = 0.4922… awrt 0.492 | A1 |
| | | (3) |
| (d) | $H_0$: $p = 0.35$ $H_1$: $p > 0.35$ | B1 |
| | Let $Y$ be the number of customers who do **not** buy free range eggs. $Y \sim N(70, 45.5)$ | M1 |
| | $P(Y \geq 86) \approx P\left(Z > \frac{85.5 - 70}{\sqrt{45.5}}\right)$ or $\pm\frac{x - 0.5 - 70}{\sqrt{45.5}} = 1.6449$ | M1 M1 |
| | $\approx 0.01078...$ or 81.595… | A1 |
| | There is evidence to reject $H_0$. In the critical region | dM1 |
| | There is evidence to support the **manager's** belief /There is evidence to support the <u>proportion</u> of customers who <u>do **not** buy free range eggs</u> is <u>more than 35%</u> (o.e) | A1 |
| | | (7) |
| | | Total 14 |

| | | |
|---|---|---|
| (a) | **M1** | Writing or using $1 - P(F, 11)$ |
| | **A1** | awrt 0.345 |
| (b) | **M1** | $P(F, 14) - P(F, 7)$ |
| | **A1** | awrt 0.811 |
| (c) | **M1** | Allow equation instead of inequality (may be implied by 2nd M1) |
| | **M1** | Writing or using $1 - P(F, 10)$ ft their 10 but must be finding the correct tail. |
| | **A1** | awrt 0.492 |
| (d) | **B1** | Both hypotheses in terms of $p$ or $\pi$ |
| | **M1** | Writing or using a normal distribution with a mean of 70 |
| | **M1** | Standardising using 85.5/86/86.5, their mean and their sd |
| | **M1** | Using a continuity correction $86 \pm 0.5$ |
| | **A1** | Correct probability awrt 0.0108 or awrt 0.0107 or $x$ value of awrt 82 or allow awrt 2.29… and 1.6449 seen<br>**NB** exact Binomial 0.01156 Po approx. awrt 0.0352 |
| | **dM1** | (dep on 1st M1) A correct statement based on comparing 86 with their CR or their prob with 0.05 [condone 0.989 > 0.95]– contradicting non-contextual comments M0 |
| | **A1** | A correct statement in context.<br>**NB** award M1A1 for a correct contextual statement on its own. |

| Question Number | Scheme | Marks |
|---|---|---|
| 2(i)(a) | $\mathrm{P}(X>14)=\frac{2}{5}$ oe | B1 |
| | | (1) |
| (b) | $a=8-2(14-8)[=-4]$ | M1 |
| | $b=14+2(14-8)[=26]$ | M1 |
| | $\mathrm{P}(6X>a\ +\ b)=\left(\frac{26-\frac{26-4}{6}}{26+4}\right)$ oe | M1 |
| | $=\frac{67}{90}$ oe awrt 0.744 | A1 |
| | | (4) |
| (ii)(a) | $S \sim \mathrm{U}[0,22.5]$ or $\mathrm{f}(s)=\begin{cases}\frac{2}{45} & 0 \leqslant s \leqslant 22.5\\ 0 & \text{otherwise}\end{cases}$ | B1 |
| | | (1) |
| (b) | $\mathrm{P}(S<12)=\frac{12}{"22.5"}$ | M1 |
| | $=\frac{8}{15}$ awrt 0.533 | A1 |
| | | (2) |
| (c) | $\mathrm{P}(T=6)={}^{20}\mathrm{C}_6\left("\frac{8}{15}"\right)^6\left(1-"\frac{8}{15}"\right)^{14}$ | M1M1 |
| | $=0.02072\ldots$ awrt 0.0207 | A1 |
| | | (3) |
| | | Total 11 |

**Notes**

| | | |
|---|---|---|
| (i)(a) | **B1** | Allow 0.4 |
| (b) | **M1** | A correct method to find the value of $a$ or $\frac{a+b}{2}=11$ May be awarded in part(a) |
| | **M1** | A correct method to find the value of $b$ or a second correct equation ft their (a) eg $\frac{b-14}{b-a}=\frac{2}{5}$ May be awarded in part(a) |
| | **M1** | A correct probability expression using their value for $a$ and their value for $b$ |
| | **A1** | Correct answer |
| (ii)(a) | **B1** | Correct distribution stated allow in words. Condone < |
| (b) | **M1** | Correct method ft their value of $(b - a)$ if positive. Condone 45 in the denominator for this mark |
| | **A1** | Awrt 0.533 |
| (c) | **M1** | For $\left("\frac{8}{15}"\right)^6\left("1-\frac{8}{15}"\right)^{14}$ |
| | **M1** | Fully correct probability ft their 8/15 |
| | **A1** | awrt 0.0207 |

| Question Number | Scheme | Marks |
|---|---|---|
| 3(a) | $4a = a(b) \Rightarrow b = 4$ * | B1*cso |
| | | (1) |
| (b) | $a(27b - 81 + 1) = 1$ | M1 |
| | $a = \dfrac{1}{28}$ | A1 |
| | | (2) |
| (c) | $P(X > 2.25) = 1 - F(2.25)$ | M1 |
| | $= 0.25237\ldots$ awrt 0.252 | A1 |
| | | (2) |
| (d)(i) | $f(x) = \frac{3}{7}x^2 - \frac{1}{7}x^3$ or $\frac{2}{7}x$ | M1 |
| |  Sketch | B1 |
| (ii) | $f'(x) = \frac{6}{7}x - \frac{3}{7}x^2$ | dM1 |
| | $\frac{6}{7}x - \frac{3}{7}x^2 = 0$ | dM1 |
| | Mode = 2 | A1 |
| | | (5) |
| | | Total 10 |

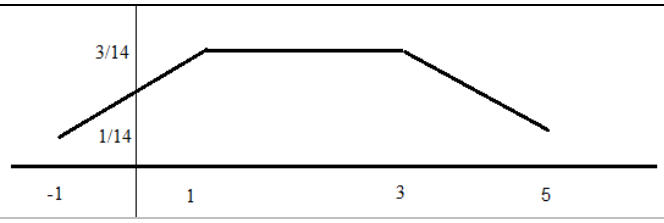
| | | Notes |
|---|---|---|
| **In this question award mark all parts together** | | |
| (a) | **B1*** | Answer given so need to see $4a = a(b)$ allow $4a(1) = a(b(1) - 1 + 1)$ followed by $b = 4$ |
| (b) | **M1** | For a correct equation |
| | **A1** | 1/28 o.e. |
| (c) | **M1** | For 1 – F(2.25) or F(3) – F(2.25) Implied by a correct answer |
| | **A1** | awrt 0.252 |
| (d)(i) | **M1** | Differentiating to find f($x$), one term correct or correct follow through. Condone missing $a$<br>Differentiation may be seen anywhere in the question.<br>$f(x) = a\left(12x^2 - 4x^3\right)$ or $8ax$ |
| | **B1** | Sketch of pdf. Straight line followed by smooth curve with mode near the middle of the curve.<br>Must be connected (no gap). Values not required, but must begin and end on horizontal axis. |
| (ii) | **dM1** | Dep on 1st M being awarded. Differentiating their f($x$) (for $1 < x \leq 3$) to find $f'(x)$<br>$x^n \rightarrow x^{n-1}$ Condone missing $a$ $f'(x) = a\left(24x - 12x^2\right)$ |
| | **dM1** | Dep on previous M being awarded. Putting their $f'(x) = 0$ |
| | **A1** | All but the B1 mark must be awarded |

| Question Number | Scheme | | Marks |
|---|---|---|---|
| 4(a) | $P(X=8)=\dfrac{e^{-6}6^8}{8!}$ or 0.8472 – 0.7440 | | M1 |
| | = 0.10325… | awrt 0.103 | A1 |
| | | | (2) |
| (b) | [ $X$~Po(6) …] $P(X \ldots n) < 0.05$ or $P(X \leqslant n-1) > 0.95$ | | M1 |
| | $n = 11$ | | A1cao |
| | | | (2) |
| (c) | $K$~Po(0.6$m$) **and** $P(K=0) < 0.05$ or $e^{-0.6m} < 0.05$ / $-0.6m < \ln 0.05$ oe | or $\lambda = 3$ | M1 |
| | $m = 5$ | | A1cao |
| | | | (2) |
| (d) | $Y$~Po(3) | | B1 |
| | $P(Y \ldots 1) = 1 - P(Y=0)$ | | M1 |
| | = 0.9502 | | A1 |
| | | | (3) |
| (e) | [ $W \sim$ Po(18)] $P(W=15)=\dfrac{e^{-18}18^{15}}{15!}$ [= 0.078575… ] | $Y \sim B(15, \frac{5}{30})$ | M1 |
| | $\dfrac{P\left(Y=1\left[\left\lvert Y \sim \text{Po}(3)\right.\right]\right)\times P\left(T=14\left[\left\lvert T \sim \text{Po}(15)\right.\right]\right)}{\text{"0.078575..."}}$ | $P(Y=1)$ | dM1 |
| | $= \dfrac{\left(e^{-3}\times 3\right)[=0.149...]\times\left(\dfrac{e^{-15}15^{14}}{14!}\right)[=0.102...]}{\text{"0.078575..."}}$ | $=15(\frac{1}{6})(\frac{5}{6})^{14}$ | dM1 |
| | = 0.1947… | awrt 0.195 | A1 |
| | | | (4) |
| (f) | $J$~Po(9) | | M1 |
| | $P(J \leqslant 13) = 0.9261$<br>$P(J \leqslant 14) = 0.9585$ | | |
| | So critical region is $J \geqslant 15$ | | A1 |
| | | | (2) |
| | | | Total 15 |

| | | Notes |
|---|---|---|
| (a) | **M1** | Correct formula or correct use of tables |
| | **A1** | awrt 0.103 |
| (b) | **M1** | A correct probability statement. Implied by correct answer |
| | **A1** | cao |
| (c) | **M1** | Forming an equation or inequality or identifying $\lambda = 3$ |
| | **A1** | cao |
| (d) | **B1** | Writing Po(3) [implied by 0.0498… or correct answer] |
| | **M1** | Writing or using $1 - P(Y=0)$ |
| | **A1** | Allow 0.95 or better |
| (e) | **M1** | Using Po(18) to find $P(W=15)$ |
| | **dM1** | (dep on 1st M1) Attempt at conditional probability with $P(Y=1)\times P(T=14)$ (any value of $\lambda$) on num. and their $P(W=15)$ on denom. (may be implied) |
| | **dM1** | (dep on 2nd M1) Correct ratio of probabilities |
| | **A1** | awrt 0.195 |
| **ALT:** | | Use of Binomial: 1st M1 correct distribution, 2nd dM1 $P(Y=1)$, 3rd dM1 correct expression |
| (f) | **M1** | Writing or using Po(9) Implied by correct CR |
| | **A1** | Cao . Allow $J>14$. Do not allow as part of a probability statement. |

| uestion Number | Scheme | Marks |
|---|---|---|
| 5(a) | P(score 8) = $0.25 \times 0.35 = 0.0875$ | B1 |
| | | (1) |
| (b) | <table><tr><th>sample</th><th>Score ($y$)</th><th>calculation</th><th>P($Y = y$)</th></tr><tr><td>(1,3)</td><td>–2</td><td>$0.4 \times 0.25$</td><td>0.1</td></tr><tr><td>(1,2)</td><td>0</td><td>$0.4 \times 0.35$</td><td>0.14</td></tr><tr><td>(1,1) (2,3)</td><td>2</td><td>$0.4^2 + 0.35 \times 0.25$</td><td>0.2475</td></tr><tr><td>(2,2)</td><td>4</td><td>$0.35^2$</td><td>0.1225</td></tr><tr><td>(2,1) (3,3)</td><td>6</td><td>$0.35 \times 0.4 + 0.25^2$</td><td>0.2025</td></tr><tr><td>(3,1)</td><td>10</td><td>$0.25 \times 0.4$</td><td>0.1</td></tr></table> | B1<br>M1<br>M1<br>M1 |
| | <table><tr><td>$Y$</td><td>–2</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td></tr><tr><td>P($Y = y$)</td><td>0.1<br>$\left[\frac{1}{10}\right]$</td><td>0.14<br>$\left[\frac{7}{50}\right]$</td><td>0.2475<br>$\left[\frac{99}{400}\right]$</td><td>0.1225<br>$\left[\frac{49}{400}\right]$</td><td>0.2025<br>$\left[\frac{81}{400}\right]$</td><td>0.0875<br>$\left[\frac{7}{80}\right]$</td><td>0.1<br>$\left[\frac{1}{10}\right]$</td></tr></table> | A1 |
| | | (5) |
| (c) | $E(Y) = -2 \times "0.1" + [0 \times "0.14"] + 2 \times "0.2475" + 4 \times "0.1225" + 6 \times "0.2025" + 8 \times 0.0875 + 10 \times "0.1"$ | M1 |
| | = 3.7 | A1 |
| | | (2) |
| | | Total 8 |

| | | Notes |
|---|---|---|
| (a) | **B1** | A correct calculation shown followed by 0.0875 |
| (b) | **B1** | For identifying the correct set of $y$ values. Any extras must have a probability of 0<br>May be split eg 2 may appear twice |
| | **M1** | For at least two correct calculations **or** probs from P($Y = -2$), P($Y = 0$) , P($Y = 4$) or P($Y = 10$) |
| | **M1** | For at least one correct calculation **or** prob for P($Y = 2$) or P($Y = 6$) |
| | **M1** | For at least four correct calculations **or** probs attached to the correct value of $y$ or sample |
| | **A1** | A fully correct answer |
| (c) | **M1** | Correct expression ft their table |
| | **A1** | 3.7 or exact equivalent |
| | | **Alternative for (c) M1**<br>$E(X) = 0.4 + 2 \times 0.35 + 3 \times 0.25 \ [= 1.85]$ and $E(Y) = 4 \times "1.85" - 2 \times "1.85"$ |

| Qu'n Number | Scheme | Marks |
|---|---|---|
| 6(a) |  | B1<br>B1 |
| | | (2) |
| (b) | $\mathrm{E}(Y)=2$ | B1 |
| | $\mathrm{Var}(2Y-3)=4\mathrm{Var}(Y)$ | M1 |
| | $\mathrm{Var}(Y)=\left(\frac{131}{21}-2^2\right)$ | M1 |
| | $\mathrm{Var}(2Y-3)=\frac{188}{21}$ awrt 8.95 | A1 |
| | | (4) |
| (c) | $\int_{-1}^{t}\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{14}\left[\frac{y^2}{2}+2y\right]_{-1}^{t}$ **or** $\int\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{14}\left[\frac{y^2}{2}+2y\right]+C$ **or** $\int\frac{1}{14}(y+2)\mathrm{d}y=\frac{1}{28}(y+2)^2+C$ | M1 |
| | $\frac{1}{14}\left[\left(\frac{t^2}{2}+2t\right)-\left(\frac{1}{2}-2\right)\right]$ **or** $\frac{1}{14}\left[\frac{(-1)^2}{2}-2\right]+C=0$ & $C=\frac{3}{28}$ **or** $\frac{1}{28}(-1+2)^2+C=0$ & $C=-\frac{1}{28}$ leading to $\frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right)$* | A1*cso |
| | | (2) |
| (d) | $\int_1^t\frac{3}{14}\mathrm{d}y+\mathrm{F}(1)=\left[\frac{3}{14}y\right]_1^t+\mathrm{F}(1)=\left[\left(\frac{3t}{14}\right)-\left(\frac{3}{14}\right)\right]+\mathrm{F}(1)$<br>or $\int\frac{3}{14}\mathrm{d}y=\left[\frac{3}{14}y\right]+C$ and use of F(1) = "their F(1)" or F(3) = " their F(3)" | M1 |
| | $\int_3^t\frac{1}{14}(6-y)\mathrm{d}y+\mathrm{F}(3)=\frac{1}{14}\left[6y-\frac{y^2}{2}\right]_3^t+\mathrm{F}(3)=\frac{1}{14}\left[\left(6t-\frac{t^2}{2}\right)-\left(18-\frac{9}{2}\right)\right]+\mathrm{F}(3)$<br>or $\int\frac{1}{14}(6-y)\mathrm{d}x=\frac{1}{14}\left[6y-\frac{y^2}{2}\right]+C$ or $C-\frac{(6-y)^2}{28}$ and use F(5) =1 | M1 |
| | $\mathrm{F}(y)=\begin{cases}0 & y\leq -1\\ \frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right) & -1<y\leq 1\\ \frac{3}{14}y+\frac{1}{14} & 1<y\leq 3\\ \frac{3}{7}y-\frac{1}{28}y^2-\frac{1}{4} & 3<y\leq 5\\ 1 & y>5\end{cases}$ | A1<br>A1<br>B1 |
| | | (5) |

| | | |
|---|---|---|
| (e) | $"\frac{3}{14}m+\frac{1}{14}"=0.3$ | M1 |
| | $m=\frac{16}{15}$ | A1 |
| | | (2) |
| | | |
| (f) | $\mathrm{P}\left(4Y\le 5 \mid Y\le 3\right)=\frac{\left(\frac{3}{14}\times\frac{5}{4}+\frac{1}{14}\right)}{\left(\frac{3}{14}\times 3+\frac{1}{14}\right)}\left[=\frac{19/56}{5/7}\right]$ | M1 |
| | $=\frac{19}{40}$ or 0.475 | A1 |
| | | (2) |
| | | Total 17 |

| | | Notes |
|---|---|---|
| (a) | **B1** | Shape correct – must not touch/cross the *x*-axis |
| | **B1** | Fully correct including labels (all *x*-axis and at least one vertical axis label which may be 2/14) |
| (b) | **B1** | Correct value for E(*Y*) |
| | **M1** | Writing or using 4 Var (*Y*) on its own |
| | **M1** | Correct formula for Var (*Y*) allow use of their E(*Y*) if clearly stated |
| | **A1** | awrt 8.95 |
| (c) | **M1** | For a correct method for $-1 < y \leqslant 1$ Allow finding the area: attempt at trapezium $\times(y+1)$ $\frac{1}{2}\left(\frac{1}{14}+\frac{1}{14}(y+2)\right)(y+1)$ |
| | **A1*cso** | A fully correct solution with substitution seen or *C* found leading to $\frac{1}{14}\left(\frac{y^2}{2}+2y+\frac{3}{2}\right)$ Allow any letter |
| (d) | **M1** | For a correct method for $1 < y \leqslant 3$ Allow finding the area $\left(\frac{1}{14}+\frac{3}{14}\right)+\frac{3}{14}(y-1)$ or $\mathrm{F}(1)+\frac{3}{14}(y-1)$ |
| | **M1** | For a correct method for $3 < y \leqslant 5$ Allow finding the area $\left(\frac{1}{14}+\frac{3}{14}\right)+\frac{6}{14}+\frac{1}{2}\left(\frac{3}{14}+\frac{1}{14}(6-y)\right)(y-3)$ or $\mathrm{F}(3)+\frac{1}{2}\left(\frac{3}{14}+\frac{1}{14}(6-y)\right)(y-3)$ |
| | **A1** | For a correct expression attached to $1 < y \leqslant 3$ |
| | **A1** | For a correct expression attached to $3 < y \leqslant 5$ Allow $\frac{29-(6-y)^2}{28}$ oe |
| | **B1** | Top, 2nd and bottom line correct plus all in terms of the same letter. Allow < for ≤ and vice versa |
| (e) | **M1** | Setting their equation for $1 < y \leqslant 3$ equal to 0.3 |
| | **A1** | cao |
| (f) | **M1** | For writing or using $\frac{\mathrm{F}(\frac{5}{4})}{\mathrm{F}(3)}$ Allow use of their expression for $3 < y \leqslant 5$ for the denominator |
| | **A1** | cao |