



Mark Scheme (Results)

October 2020

Pearson Edexcel International A Level
in Statistics S2 (WST02/01)

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General Marking Guidance

- 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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL IAL MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
 - **M** marks: method marks are awarded for ‘knowing a method and attempting to apply it’, unless otherwise indicated.
 - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
 - **B** marks are unconditional accuracy marks (independent of M marks)
 - Marks should not be subdivided.
3. Abbreviations

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

- bod – benefit of doubt
 - ft – follow through
 - the symbol \surd will be used for correct ft
 - cao – correct answer only
 - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
 - isw – ignore subsequent working
 - awrt – answers which round to
 - SC: special case
 - oe – or equivalent (and appropriate)
 - dep – dependent
 - indep – independent
 - dp decimal places
 - sf significant figures
 - * The answer is printed on the paper
 - \square The second mark is dependent on gaining the first mark
4. All A marks are ‘correct answer only’ (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.
 5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
 6. Ignore wrong working or incorrect statements following a correct answer.

| Question Number | Scheme | | Marks |
|-----------------|--|--|-----------------|
| 1 (a) | $\int_1^2 k \left(\frac{1}{2}x^3 - 3x^2 + ax + 1 \right) dx [=1]$ | | M1 |
| | $k \left[\frac{1}{8}x^4 - x^3 + \frac{1}{2}ax^2 + x \right]_1^2 [=1]$ | | A1 |
| | $k(2-8+2a+2) - k\left(\frac{1}{8}-1+\frac{1}{2}a+1\right) = 1$ or $k(2a-4) - k\left(\frac{1}{8}+\frac{1}{2}a\right) = 1$ | | dM1 |
| | $-\frac{33}{8}k + \frac{3}{2}ka = 1 \therefore k(12a-33) = 8^*$ | | A1 * |
| | | | (4) |
| (b) | $\frac{df(x)}{dx} = k \left(\frac{3}{2}x^2 - 6x + a \right)$ | | M1 |
| | $\frac{3}{2}x^2 - 6x + 5 = 0$ or $\frac{4}{9}x^2 - \frac{16}{9}x + \frac{40}{27} = 0$ | | dM1 |
| | $x = \frac{6 \pm \sqrt{6^2 - 4 \times 1.5 \times 5}}{3}$ | | M1 |
| | $x = 2 - \frac{\sqrt{6}}{3}$ oe or 1.183... | | awrt 1.18 A1 |
| | | | (4) |
| Notes | | | Total 8 |
| 1(a) | M1 | Attempting to integrate f(x), (at least one term $x^n \rightarrow x^{n+1}$). Ignore limits. No Need to equate to 1 | |
| | A1 | Fully correct integration. Allow not simplified. Ignore limits and accept any letters. Allow + C No Need to equate to 1 | |
| | dM1 | Dep on 1 st M1. Subst in correct limits, subtracting results and equate to 1 Allow if they have + C the use of F(2) = 1 and F(1) = 0 to form 2 equations and solve to eliminate + C | |
| | A1* | Answer is given. Correct solution only. At least one correct line of working required between $k(2a-4) - k\left(\frac{1}{8} + \frac{1}{2}a\right) = 1$ and the final given answer. | |
| (b) | M1 | Attempting to differentiate f(x), (at least one term $x^n \rightarrow x^{n-1}$). Condone missing k or incorrect value for k | |
| | dM1 | Dependent on first Method mark being awarded. Putting their differential (or multiple of) = 0 May be implied by awrt 1.18 or awrt 2.82 | |
| | M1 | Correct method for solving their 3 term quadratic equation. May be implied by awrt 1.18 or awrt 2.82 Minimum for method if final answer is incorrect is of the form $\frac{6 \pm \sqrt{6}}{3}$ | |
| | A1 | Allow equivalent exact answer. awrt 1.18 Must eliminate the 2.816... or clearly indicate which of the 2 solutions is their answer | |

| Question Number | Scheme | | Marks |
|-----------------|--|--|--|
| 2(a) | $f(w) = \begin{cases} \frac{1}{8} & -1.4 < w < 6.6 \\ 0 & \text{otherwise} \end{cases}$ | | M1 A1 (2) |
| (b) | E(W) = 2.6 oe | | B1 (1) |
| (c) | $(1.6 - \alpha) \times \frac{1}{8} = 0.35$ $\alpha = -1.2 \text{ oe}$ | | M1 A1cso (2) |
| (d) | $P(1.2 < W < 2.4) = (2.4 - 1.2) \times \frac{1}{8}$ $= \frac{3}{20} \text{ or } 0.15 \text{ oe}$ | | M1 A1ft (2) |
| (e) | $P(W > 2 \mid 1.2 < W < 2.4) = \frac{0.4 \times \frac{1}{8}}{0.15}$ $= \frac{1}{3} \quad \text{awrt } 0.333$ | | M1 A1 (2) |
| (f) | The random variable Y is the number of days the train is between 1.2 minutes and 2.4 minutes late $Y \sim B(40, "0.15")$ | | M1 |
| | P(Y ≥ 10) = 1 - P(Y ≤ 9) or 1 - 0.9328 | | M1 |
| | = 0.0672 awrt 0.0672 | | A1 (3) |
| Notes | | | Total 12 |
| 2(a) | M1 | pdf of the form $f(w) = \begin{cases} p & -1.4 < w < 6.6 \\ 0 & \text{otherwise} \end{cases}$ | where p is a probability allow use of ≤ instead of one/both < signs. Allow equivalent for the 0 otherwise. Allow any letter/mix of letters |
| | A1 | Fully correct allow use of ≤ instead of one/both < signs. Allow any letter but must be consistent. | |
| (b) | B1 | 2.6 oe | |
| (c) | M1 | setting up equation $(1.6 - \alpha) \times \text{"their } p\text{"} = 0.35$ with $0 < p < 1$ or $\frac{7}{20} = \frac{2.8}{8}$ and $\alpha = 1.6 - \text{"2.8"}$ or $F(1.6) - F(\alpha) = 0.35$ using their F(w) in the form $bw + c$ where $0 < b < 1$ Allow for $\int_{\alpha}^{1.6} \text{"their } f(w)\text{"} dw = 0.35$ oe with an attempt to integrate (at least one term correct). | |
| | A1 cso | If using $F(1.6) - F(\alpha) = 0.35$ then F(w) must be correct. Allow different letters | |
| (d) | M1 | $(2.4 - 1.2) \times \text{"their } p\text{"}$ where $\text{"their } \frac{1}{8}\text{"}$ is a probability or $F(2.4) - F(1.2)$ using their F(w) in the form $bw + c$ where $0 < b < 1$ Implied by 0.15 Allow for $\int_{1.2}^{2.4} \text{"their } f(w)\text{"} dw$ with an attempt to integrate (at least one term correct). | |
| | A1ft | Ft their p as long as the answer is a probability | |
| (e) | M1 | $\frac{0.4 \times \text{"their } \frac{1}{8}\text{"}}{\text{"their (d)"}}$ or $\frac{0.4}{\text{"1.2"}}$ implied by $\frac{1}{3}$ Allow for $\int_2^{2.4} \text{"their } f(w)\text{"} dw$ with an attempt to integrate (at least one term correct) for numerator | |
| | A1 | Allow 0.3̇ or 0.33̇ | |
| (f) | M1 | Writing or using B(40, "their 0.15") Implied by mean of $40 \times \text{"their (d)"}$ | |
| | M1 | Writing or using $1 - P(Y \leq 9)$ Allow for $1 - P\left(z \leq \frac{9.5 \text{ or } 9 - \text{"their mean"}}{\text{"their sd"}}\right)$ | |
| | A1 | awrt 0.0672 | |

| Question Number | Scheme | | Marks |
|-----------------|---|---|-----------------|
| 3(a)(i) | $X \sim B(10, 0.45)$ | | M1 |
| | $P(X \leq 1) = 0.0233$ | awrt 0.0233 | A1 |
| (ii) | $P(X \geq 6) = 1 - P(X \leq 5)$ or $1 - 0.7384$ | | M1 |
| | $= 0.2616\dots$ | awrt 0.262 | A1 |
| | | | (4) |
| (b) | $F \sim N(54, 29.7)$ | | M1A1 |
| | $\frac{c + 0.5 - 54}{\sqrt{29.7}} \leq -1.6449$ | or $\frac{d - 0.5 - 54}{\sqrt{29.7}} \geq 1.6449$ | M1M1B1 A1 |
| | $c = 44$ and $d = 64$ | | A1cso |
| | | | (7) |
| (c) | $H_0: p = 0.45$ $H_1: p < 0.45$ | | B1 |
| | $Y \sim B(30, 0.45)$ therefore $P(Y \leq 8) = 0.03\dots$ or CR $Y \leq 8$ | | B1 |
| | 8 is in the critical region or Reject H_0 oe or significant | | dM1 |
| | therefore the data collected supports the manufacturer's claim. | | A1 |
| | | | (4) |
| Notes | | | Total 15 |
| (a)(i) | M1 | Writing or using $B(10, 0.45)$ in (i) or (ii) implied by a correct answer to (i) or (ii) | |
| | A1 | awrt 0.0233 | |
| (ii) | M1 | For writing or using $1 - P(X \leq 5)$ oe | |
| | A1 | awrt 0.262 | |
| (b) | M1 | For writing or using $N(54, \dots)$ | |
| | A1 | For writing or using $N(54, 29.7)$ | |
| | M1 | For standardising (allow \pm) using their "54" and "29.7" and putting = to z value where $1 < z < 2$ Condone missing ± 0.5 | |
| | M1 | M1 for using a continuity correction ± 0.5 in standardisation. No need to put = to z value | |
| | B1 | For using 1.6449 or better (calc gives) 1.64485... Allow if written then gone on to use 1.65 or 1.64 or better in equation | |
| | A1 | One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or better | |
| | A1cso | All previous marks awarded. Both c and d correct integers | |
| | | NB: c and d correct with no working can be awarded full marks | |
| (c) | B1 | Both hypotheses correct in terms of p or π Must be attached to H_0 and H_1 | |
| | B1 | 0.03 or better (0.03120...) or CR stated as $Y \leq 8$ oe do not accept $P(Y \leq 8) = \dots$ for CR Condone 0.97 or better (0.96879...) | |
| | dM1 | Dep on 2 nd B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given. | |
| | A1 | Correct conclusion for their H_1 . If H_1 is 2-tail the opposite conclusion must be given. No hypotheses or $H_1 p > 0.45$ is A0. Allow belief instead of claim. Allow the data collected supports that the proportion/percentage/probability/number/amount oe of flawed plates has decreased/reduced/is not 0.45/has changed oe | |

| Question Number | Scheme | | Marks |
|-----------------|--|--|-----------------|
| 4(a) | Common Spotted-orchids occur singly/randomly/independently | | B1 |
| | | | (1) |
| (b)(i) | $S \sim \text{Po}(4.5)$ | | |
| | $P(S = 6) = \frac{e^{-4.5} 4.5^6}{6!}$ or $P(S \leq 6) - P(S \leq 5)$ | | M1 |
| | $= 0.1281\dots$ | | awrt 0.128 A1 |
| (ii) | $P(4 < S < 10) = P(S \leq 9) - P(S \leq 4)$ or $0.9829 - 0.5321$ | | M1 |
| | $= 0.4508$ | | awrt 0.451 A1 |
| | | | (4) |
| (c) | $H_0 : \lambda = 9 \quad H_1 : \lambda > 9$ | | B1 |
| | $M \sim \text{Po}(9) \quad P(M \geq 11) = 1 - P(M \leq 10)$ or $P(M \geq 15) = 0.0415$ | | M1 |
| | $= 0.294$ or CR $M \geq 15$ | | A1 |
| | Accept H_0 or insignificant or 11 does not lie in the critical region | | dM1 |
| | There is insufficient evidence to support Juan's belief | | A1 |
| | | | (5) |
| (d) | $T \sim N(90, 90)$ | | B1 |
| | $P(T < 70) = P\left(Z < \pm \left(\frac{69.5 - 90}{\sqrt{90}}\right)\right)$ or $P(Z < \pm 2.160\dots\dots)$ | | awrt 2.16 M1 |
| | $= 0.0154$ | | awrt 0.0154 A1 |
| | | | (3) |
| (e) | $V \sim \text{Po}(200 \times 0.012) = \text{Po}(2.4) \quad V \sim = \text{Po}(2.4)$ | | M1 |
| | $P(V = 0) + P(V = 1) = e^{-2.4}(1 + 2.4)$ | | dM1 |
| | $= 0.30844\dots$ | | awrt 0.308 A1 |
| | | | (3) |
| Notes | | | Total 16 |
| 4(a) | B1 | One of the given reasons. No context needed | |
| (b)(i) | M1 | For $\frac{e^{-\lambda} \lambda^6}{6!}$ with any value for λ or writing or using $P(S \leq 6) - P(S \leq 5)$ | |
| | A1 | awrt 0.128 | |
| (ii) | M1 | Writing or using $P(S \leq 9) - P(S \leq 4)$ | |
| | A1 | awrt 0.451 | |
| (c) | B1 | Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 instead of 9. | |
| | M1 | Writing or using $\text{Po}(9)$ and $1 - P(M \leq 10)$ or $P(M \geq 15) = 0.0415$ oe Implied by correct CR or awrt 0.3 or 0.29... or better (0.2940...) | |
| | A1 | 0.3 or 0.29... or better (0.2940...) or $M \geq 15$ oe SC: Condone $P(X \leq 10) = 0.7$ or better (0.705988....) for M1A1 | |
| | dM1 | Dep on M1 A1. A correct statement– no context needed but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given. | |
| | A1 | Correct conclusion. If H_0 is 2- tail the opposite conclusion must be given. No hypotheses or $H_0 \lambda < 9$ gets A0. Allow claim instead of belief. Alternative: There is insufficient evidence to support hat the number of Common Spotted-orchids has increased/ /is not 9/has changed oe (with the bold words included). | |
| (d) | B1 | Writing or using $N(90, 90)$ | |
| | M1 | Standardising with 68.5 or 69.5 or 70.5 and their mean and sd | |
| | A1 | awrt 0.0154 NB Poisson gives 0.01275... | |
| (e) | M1 | Writing or using $\text{Po}(200 \times 0.012)$ Allow $\text{Po}(200 \times \text{"their d"})$ | |
| | dM1 | Dependent on using Poisson. For using / writing $P(V = 0) + P(V = 1)$ or $e^{-\lambda}(1 + \lambda)$ or $P(V \leq 1)$ oe | |
| | A1 | awrt 0.308 NB Binomial gives 0.3066 | |

| Question Number | Scheme | | Marks |
|-----------------|---|--|-----------------|
| 5(a) | $E(T^2) = \int_0^3 \frac{1}{50}(18t^2 - 2t^3) dt + \int_3^5 \frac{1}{20}t^2 dt$ | | M1 |
| | $= \left[\frac{1}{50} \left(6t^3 - \frac{t^4}{2} \right) \right]_0^3 + \left[\frac{t^3}{60} \right]_3^5$ or $= \left[\frac{3}{25}t^3 - \frac{t^4}{100} \right]_0^3 + \left[\frac{t^3}{60} \right]_3^5$ oe | | A1 |
| | $= \frac{1}{50} \left(6 \times 3^3 - \frac{3^4}{2} \right) + \left(\frac{125}{60} - \frac{27}{60} \right)$ or $= \frac{1}{50} \left(162 - \frac{81}{2} \right) + \left(\frac{25}{12} - \frac{9}{20} \right)$ oe | | M1d |
| | $= \frac{1219}{300} = 4.063\dots$ | | |
| | $\text{Var}(T) = "4.063\dots" - (1.66)^2$ | | M1 |
| | $= 1.3077\dots$ | | awrt 1.31 A1 |
| | | | (5) |
| (b) | $\int_3^t \frac{1}{20} dx + C$ where $C = 0.9$ or $\int_0^3 \frac{1}{50}(18-2t) dt$ or using $F(5) = 1$ to find C | | M1 |
| | $[F(t) =] \begin{cases} 0 & t < 0 \\ \frac{1}{50}(18t - t^2) \text{ or } 1.62 - \frac{(18-2t)^2}{200} & 0 \leq t \leq 3 \\ \frac{1}{20}t + 0.75 & 3 < t \leq 5 \\ 1 & t > 5 \end{cases}$ | | B1 |
| | | | A1 |
| | | | A1 |
| | | | (4) |
| (c) | $P(T > 2) = 1 - \frac{1}{50}(18 \times 2 - 2^2)$ or $1 - \int_0^2 \frac{1}{50}(18-2t) dt$ | | M1 |
| | $= \frac{9}{25}$ or 0.36 | | A1 |
| | | | (2) |
| (d) | $P(0 < T < 3.66) = F(3.66)$ | | M1 |
| | $= 0.933$ | | A1 |
| | | | (2) |
| Notes | | | Total 13 |
| (a) | M1 | Intention to find $E(T^2)$ correctly. They must add the 2 integrals and attempt to integrate (at least one term $x^n \rightarrow x^{n+1}$). Algebraic integration must be seen. Ignore limits. Allow as part of $\text{Var}(T)$ condone $" - (1.66)^2"$ occurring twice. If no algebraic integration shown it is M0 | |
| | A1 | Correct integration | |
| | M1d | dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or 1219/300 or 243/100 or 49\30 oe | |
| | M1 | For their $E(T^2) - 1.66^2$ | |
| | A1 | awrt 1.31 Allow 2452 / 1875 oe | |
| (b) | M1 | For a correct method to find the 3 rd line including limits unless using $F(5) = 1$ method. | |
| | B1 | 2 nd line correct – any letter. Ignore missing inequality | |
| | A1 | 3 rd line correct– any letter. Ignore missing inequality | |
| | A1 | Fully correct CDF All in terms of the same letter (Ignore LHS). Allow $<$ instead of \leq and vice versa. Allow "otherwise" for the range on the 1 st or last line but not both. | |
| (c) | M1 | For finding $1 - F(2)$ using their second line or starting again. Must subst in 2 | |
| | A1 | cao | |
| (d) | M1 | For realising they need $F(3.66)$ Allow $F(3.66) [- F(0)]$ allow $F("their\ mean + 2") [- F(0)]$ | |
| | A1 | Cao allow answer as a fraction | |

| Question Number | Scheme | | | | Marks | |
|-----------------|--|--|------|------|-----------------|-------|
| 6(a) | A sampling distribution is all the values of a statistic and the associated probabilities or the probability distribution of the statistic . | | | | B1 (1) | |
| (b) | P(small(40)) = 0.5, P(medium(80)) = 0.3, P(large(150)) = 0.2 | | | | B1 | |
| | Range (R) 0, 40, 70, 110 | | | | B1 | |
| | $[P(R=0) =]0.5^3 + 0.3^3 + 0.2^3 = 0.16$ | | | | M1 | |
| | (40,40,80) (40,80,80) (80,80,150) (80,150,150) (40,40,150) (40,80,150) (40,150,150) | | | | B1 | |
| | $[P(R=40) =]3 \times (0.5 \times 0.3^2) + 3 \times (0.5^2 \times 0.3)$ | | | | M1 M1 | |
| | $[P(R=70) =]3 \times (0.3^2 \times 0.2) + 3 \times (0.3 \times 0.2^2) = 0.09$ | | | | | |
| | $[P(R=110) =]3 \times (0.5^2 \times 0.2) + 3 \times (0.5 \times 0.2^2) + 6 \times (0.5 \times 0.3 \times 0.2) = 0.39$ | | | | | |
| | R | 0 | 40 | 70 | 110 | A1cao |
| | r | 0.16 | 0.36 | 0.09 | 0.39 | |
| | | | | | (7) | |
| (c) | $(1 - 0.09)^n < 0.2$ or $(0.91)^n < 0.2$ | | | | M1 | |
| | $[n >]17.065...$ | | | | M1 | |
| | $n = 18$ | | | | A1 | |
| | | | | | (3) | |
| Notes | | | | | Total 11 | |
| 6(a) | B1 | A correct explanation with the words in bold. Allow equivalent words eg outcomes for values | | | | |
| (b) | B1 | Correct probabilities – may be seen in an equation or implied by a correct probability for $R = 0$ or for 2 correct probabilities from those for $R = 40, R = 70, R = 110$ | | | | |
| | B1 | All four ranges correct with no extra. | | | | |
| | M1 | Correct method for finding $P(R = 0)$ | | | | |
| | B1 | All the correct combinations for $R = 40, 70$ and 110 . $R = 0$ combinations are not required but no incorrect combinations must be seen (may use bag size rather than numbers in bag) May be implied by a correct probability for $P(R = 40), P(R = 70)$ and $P(R = 110)$ or by correct working seen for each of the 7 combinations (no need for the number of ways of arranging ie $3 \times$ or $6 \times$) eg $(40,40,80) = 0.5^2 \times 0.3$ | | | | |
| | M1 | Correct method for one of the probabilities for $P(R = 40), P(R = 70), P(R = 110)$ | | | | |
| | M1 | Correct method for a second probability for $P(R = 40), P(R = 70), P(R = 110)$ or the 4 probabilities add up to 1. | | | | |
| | A1 | Correct answer only. Allow answers as a fraction. Need not be in a table but probabilities must be attached to the correct range | | | | |
| (c) | M1 | Setting up a correct inequality using their 0.09 Allow written as an equation. | | | | |
| | M1 | For 17.1 or better allow $\frac{\log 0.2}{\log 0.91}$ or $\log_{0.91} 0.2$ oe If inequality/equation is incorrect but of the form $(p)^n < 0.2$ $(p)^n = 0.2$ where $0 < p < 1$ this mark can be awarded if working is shown | | | | |
| | A1 | 18 do not accept $n > 18$ or $n < 18$ if final answer | | | | |

