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Mark Scheme (Results)

Summer 2014

Pearson Edexcel International A Level in Statistics 2
(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
- $\ast$ The answer is printed on the paper
- $\overline{}$ 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)	n- large (allow $n > 50$ or any number greater than 50) ["too" large is OK] p – small (allow $p < 0.2$ or a probability less than 0.2)	**B1** **(1)**
(b)	$H_0 : p = 0.009$ $H_1 : p > 0.009$	**B1** **(1)**
(c)	Po(4.5)	**B1**
	Probability / **Critical Region (CR)**	
	$P(X \geq 9) = 1 - P(X \leq 8)$ / $P(X \leq 7) = 0.9134$	**M1**
	$= 1 - 0.9597$ / $P(X \leq 8) = 0.9597$	
	$= 0.0403$ / CR $X \geq 9$	**A1**
	Reject H_0 or Significant or 9 is in the Critical region. There is evidence that the farmer's claim is true. Or There is evidence that the proportion of eggs with a double yolk is > 0.009	**M1d** **A1cso** **(5)**
		[7]

	Notes
(b)	B1 both hypotheses correct. Must mention p (or π). Words only is B0
(c)	B1 writing or using Po(4.5)(Check their probs using tables if Po(4.5) is not seen) 1st M1 writing $1 - P(X \leq 8)$ May be implied by sight of 1 – 0.9597 or for CR method: $P(X \leq 7) = 0.9134$ or $P(X \leq 8) = 0.9597$ (NB may see $P(X \leq 9) = 0.9829$ Allow this if trying a two-tail test and CR approach) They can score M1 for writing $1 - P(X \leq 8)$ even if they later go on to use another distribution such as B(500, 0.009). Exact binomial gives 0.039526... but scores A0 1st A1 for probability awrt 0.0403 or CR of $X > 8$ or $X \geq 9$ Allow awrt 0.9597 if accompanied by a correct comparison with 0.95 2nd dM1 correct statement that must agree with hypotheses. Dependent on B1 Contradictory non-contextual ststements such as "not significant" so "reject H_0" score M0 2nd A1cso correct contextual statement. Depends on all other marks in (c) being scored. Must mention "farmer" and "claim" or "eggs" and "double yolk" NB A correct calculation followed only by a correct contextual comment scores the final M1(implied) and A1
2-tail	If 2-tail hypotheses in (b) Score B0 in (b) Could score B1 M1A1and M1 for a correct non contextual comment but A0 since they should not be rejecting H_0 in this case (or they have scored A0 earlier so not cso)

Question Number	Scheme	Marks
2. (a)	$\int_0^2 k\left(4-y^2\right)\mathrm{d}y[=1]$ <u>or</u> attempt F(y)	**M1**
	$k\left[4y-\frac{y^3}{3}\right]_0^2[=1]$ F(y) = $k\left[4y-\frac{y^3}{3}\right]$	**A1**
	$k\left[4\times2-\frac{2^3}{3}\right]=1$ <u>or</u> must use F(2) = 1	**M1d**
	$k=\frac{3}{16}$ **(*)**	**A1cso** **(4)**
(b)	$\mathrm{E}(Y)=\frac{3}{16}\int_0^2\left(4y-y^3\right)\mathrm{d}y$	**M1**
	$=\frac{3}{16}\left[2y^2-\frac{y^4}{4}\right]_0^2$, $=\frac{12}{16}$ or 0.75	**A1, A1**
	= 750 (kg)	**A1cao** **(4)**
(c)	$\mathrm{E}(Y^2)=\frac{3}{16}\int_0^2 4y^2-y^4\mathrm{d}y$	**M1**
	$=\frac{3}{16}\left[\frac{4y^3}{3}-\frac{y^5}{5}\right]_0^2$ (= 0.8)	**A1**
	$\mathrm{Var}(Y)=0.8-0.75^2$	**M1**
	$=0.2375$	**A1**
	Standard deviation = 0.48734... or 487 (kg)	**A1** **(5)**
(d)	$\mathrm{P}(Y>1.5)=\frac{3}{16}\int_{1.5}^2\left(4-y^2\right)\mathrm{d}y$ <u>or</u> $1-\frac{3}{16}\left[4y-\frac{y^3}{3}\right]_0^{1.5}$	**B1** **M1**
	$=\frac{3}{16}\left[4y-\frac{y^3}{3}\right]_{1.5}^2$ <u>or</u> $1-\frac{3}{16}\left[4y-\frac{y^3}{3}\right]_0^{1.5}=0.0859$ or $\frac{11}{128}$	**A1** **(3)**
		[16]

	Notes
(a)	1st M1 attempting to integrate f(y), (at least one term $y^n \to y^{n+1}$). Ignore limits. 1st A1 fully correct integration. Ignore limits and accept any letters. 2nd dM1 dep on 1st M1. Subst in correct limits – condone not seeing 0 substituted. 2nd A1 cso – no incorrect working seen. "Verifying" requires statement "so k = …" here NB An "= 1" must appear somewhere <u>before</u> the line $\frac{16k}{3}=1$
(b)	1st M1 Attempting to integrate yf(y), (at least one term $y^n \to y^{n+1}$). Ignore limits 1st A1 correct integration which must be shown. **No integration loses all 4 marks** 2nd A1 0.75 or any exact equivalent. May be implied by a correct ans. of 750 (kg) 3rd A1cao 750 only. Condone missing "kg"
(c)	1st M1 Attempting to integrate y^2f(y) (at least one term $y^n \to y^{n+1}$). Ignore limits. Condone in $\sqrt{}$ 1st A1 correct integration. Condone inside $\sqrt{}$. May be implied by sight of 0.8 2nd M1 using E(Y^2) – [E(Y)]^2 follow through their E(Y^2) and E(Y)^2 Must see values <u>used</u> 2nd A1 0.2375 may be implied by correct sd. Allow $\frac{19}{80}$ or exact equivalent 3rd A1 awrt 0.487 or awrt 487. (no fractions)
(d)	B1 using 1.5 in an integral or 1 – F(1.5). Must be part of a correct expression. M1 Correct integration and at least intention to use correct limits so 1.5, 2 or 0, 1.5 seen A1 awrt 0.0859 or $\frac{11}{128}$ or exact equivalent

Question Number	Scheme	Marks
3. (a)	$\left[\mathrm{E}(T)=\dfrac{\alpha+\beta}{2}=2\right], \Rightarrow \alpha+\beta=4$	**, B1**
	$\left[\mathrm{Var}(T)=\dfrac{(\beta-\alpha)^2}{12}=\dfrac{16}{3}\right], \Rightarrow (\beta-\alpha)^2=64$	**, B1**
	$\alpha=-2, \beta=6$	**M1 A1 A1**
		(5)
(b)	$\mathrm{P}(T<3.4)=\dfrac{1}{8}\times(5.4)$	**M1**
	$=0.675$	**A1**
		(2)
		[7]

	Notes
(a)	1st B1 $\alpha+\beta=4$ oe
	2nd B1 $(\beta-\alpha)^2=64$ oe allow $(\beta-\alpha)=+8$ or $(\beta-\alpha)=-8$ or $3(\beta-\alpha)^2=192$
	May be implied by a correct equation in one variable
	M1 Correct processes to obtain a correct equation in one variable. Allow one slip.
	e.g. $(\beta-[4-\beta])^2=64$ <u>or</u> $2\beta=12$ <u>or</u> $4\alpha^2-16\alpha-48=0$ <u>or</u> $(2-\alpha)^2=16$
	1st A1 $\alpha=-2,$
	2nd A1 $\beta=6$
	If both correct answers only appear then this implies all 5 marks.
(b)	M1 $\dfrac{1}{\pm \text{ their "}(\beta-\alpha)\text{"}}\times(3.4-\text{'their }\alpha\text{'})$ If their nexpression is –ve or > 1 then M0
	A1 0.675 or exact equivalent e.g. $\frac{27}{40}$

Question Number	Scheme	Marks
4. (a)	$P(L > 100) = P\left(Z > \frac{100-\mu}{0.5}\right) = 0.3$	
	$\Rightarrow \frac{100-\mu}{0.5} =, \ 0.5244$	**M1 B1**
	$\mu = 99.7378...$ cm awrt 99.7	**A1**
		(3)
(b)	X represents number more than 100cm. $X \sim B(12, 0.3)$	**B1**
	$P(X \leq 2) = 0.2528$ awrt 0.253	**M1A1**
		(3)
(c)	Normal approximation $\mu = 400 \times 0.3 = 120, \ \sigma^2 = 84$	**M1, A1**
	$P(X > 127) \approx 1 - P(Z < \frac{127.5-120}{\sqrt{84}})$ ± 0.5, standardise	**M1, M1, A1**
	$\approx 1 - P(Z < 0.818\ )$	
	$= 1 - 0.7939$	
	$= 0.206$ or 0.207	**A1**
		(6)
		[12]

	Notes
(a)	M1 standardising ($\pm$) with 100, μ and 0.5 and setting equal to a z value. $0.5 < z < 0.7$
	NB Use of $z = 0.7$ scores M0B0A0
	B1 $z = \pm 0.5244$ or better (Calc. Gives 0.5244005...). Must be used in an equation for μ.
	A1 awrt 99.7. Answer only is 0/3
	NB M1 + answer only of awrt 99.7 scores M1B0A1 but allow B1 for $99.7376 \leq \mu \leq 99.7379$
(b)	B1 writing B(12, 0.3)
	M1 writing $P(X \leq 2)$ May be implied by sight of 0.252 or 0.253.
	NB $P(X < 3)$ alone is M0 unless they show that $P(X < 3) = P(X = 0) + P(X = 1) + P(X = 2)$
	A1 awrt 0.253. Answer only scores 3/3
(c)	1st M1 attempting to use a Normal approx. State $N(\mu, \sigma^2)$ with μ or σ correct
	1st A1 correct mean and var/sd
	2nd M1 continuity correction used: either 127.5 or 126.5 seen
	3rd M1 standardising with their μ and σ and finding correct area. Must lead to P(Z > +ve) (o.e.)
	2nd A1 $\frac{127.5-120}{\sqrt{84}}$ or awrt 0.82
	3rd A1 for awrt 0.206 or 0.207

Question Number	Scheme	Marks
5. (a)(i)	$H_0 : p = 0.35 \quad H_1 : p \neq 0.35$	**B1**
(ii)	B(15,0.35)	**M1**
	CR $X \leq 1 \cup X \geq 10$ (Allow any letter)	**A1A1**
		(4)
(b)	8 is not in CR	**M1**
	There is evidence that the Company's claim is true	**A1ft**
		(2)
(c)	0.0142 + 0.0124 = 0.0266	**B1**
		(1)
		[7]

	Notes
(a) (i)	B1 both hypotheses correct. Must mention p (or π). Words only is B0
(ii)	M1 Writing B(15,0.35) May be implied by e.g. P($X \leq 1$) =0.0142 or P($X \leq 9$) = 0.9876
	1st A1 $X \leq 1$ (accept $X < 2$) Allow $0 \leq X \leq 1$ but P($X \leq 1$) is A0
	2nd A1 $X \geq 10$ (accept $X > 9$) Allow $10 \leq X \leq 15$ but P($X \geq 10$) is A0
	Either correct answer will imply M1
(b)	M1 for a reason that matches their CR. "Interpret" their CR of P($X \geq 10$) as $X \geq 10$ etc
	Allow calculation of P($X \geq 8$) = 1 – 0.8868 = 0.1132 and "not sig" comment
	Do not allow contradictory remarks e.g. 8 is not in CR so significant (this gets M0)
	A1ft for a conclusion correct for their CR in context
	Must mention "claim" or "peas" and "germinating"
	NB A correct contextual claim on its own scores M1A1
(c)	B1 for 0.0266 or awrt 0.0266 (calc gives 0.02662196...)

Question Number	Scheme	Marks
6. (a)	F(1.23) = awrt 0.495 F(1.24) = awrt 0.501 0.5 lies between therefore median value lies between 1.23 and 1.24	**M1** **A1** **A1** **(3)**
(b)	$[f(x)=]\begin{cases}\frac{9x}{10}-\frac{3x^2}{10} & 0\le x\le 2\\ 0 & \text{otherwise}\end{cases}$	**M1A1** **B1** **(3)**
(c)	$\frac{18}{20}-\frac{12x}{20}=0$ or completeing square so: $\frac{3}{10}\left[\frac{9}{4}-\left(x-\frac{3}{2}\right)^2\right]$ $x = 1.5$	**M1** **A1** **(2)**
(d)	Median < mode, negative skew	**M1,A1** **(2)**
		[10]

	Notes
(a)	M1 attempt at both F(1.23) and F(1.24) and at least one correct or $\frac{x^2}{20}(9-2x)=0.5$ 1st A1 both awrt 0.495 and awrt 0.501 or 1.238 2nd A1 correct comment about the value of the median (not just 0.495 < F(m) < 0.501)
(b)	M1 attempting to differentiate. Multiply out and at least one term $x^n \to x^{n-1}$ A1 correct differentiation. Allow $\frac{18x}{20}-\frac{6x^2}{20}$ or $\frac{3}{10}x(3-x)$ or any exact equivalent. B1 correct pdf, including 0 otherwise and $0 \le x \le 2$
(c)	M1 for an attempt to differentiate pdf and put = 0 or complete the square or a sketch Sketch should have the correct shape and show some positive values on x – axis. An attempt at completing the square should get to $p \pm q(x-1.5)^2$ Answer only scores M1A1
(d)	M1 reason must match their values/ sketch (NB mean = 1.2) . Their values must be in [0, 2] No mode or median will score M0 unless their reason is based on their sketch A1 no ft correct answer only e.g. If their mode = 1 and they say "mode < median" score M1 for a correct reason but A0 even if they say "positive skew" since there is no ft and "negative skew" would follow incorrect working.

Question Number	Scheme	Marks
7. (a)	F represents number of flaws per 50 m $\Rightarrow F \sim$ Po(2)	
	$P(F = 5) = 0.9834 - 0.9473$ or $\dfrac{e^{-2}2^5}{5!}$	**M1**
	$= 0.0361$	**A1 (2)**
(b)	G represents number of flaws per 200 m $\Rightarrow G \sim$ Po(8)	**B1**
	$P(G < 7) = P(G \leq 6) = 0.3134$	**B1**
	[R = number of 200 m rolls containing fewer than 7 flaws.] $R \sim$ B(4, 0.3134)	**M1A1ft**
	$P(R = 1) = C_1^4 \times 0.3134 \times (1 - 0.3134)^3 = 0.40576...$ awrt 0.406	**M1 A1 (6)**
(c)	N represents number of flaws in a x m roll $\Rightarrow N \sim$ Po(λ)	
	$P(N < 26) = P\left(\dfrac{25.5 - \lambda}{\sqrt{\lambda}}\right)$ ± 0.5, standardise	**M1, M1 A1**
	$\dfrac{25.5 - \lambda}{\sqrt{\lambda}} = 0.1$ gives $\lambda + 0.1\sqrt{\lambda} - 25.5 = 0$	**B1**
	$\sqrt{\lambda} = \dfrac{-0.1 \pm \sqrt{0.1^2 + 4 \times 25.5}}{2}$	**dM1**
	$\left[\sqrt{\lambda} = 5\right]$ so $\lambda = 25$	**A1**
	$x = \dfrac{25}{2} \times 50$, so $x = 625$ m	**dM1** **A1 (8)**
		[16]

	Notes
(a)	M1 Writing $P(X \leq 5) - P(X \leq 4)$ or $\dfrac{e^{-\lambda}\lambda^5}{5!}$ (any value of λ) A1 awrt 0.0361
(b)	1st B1 Writing or using Po(8) 2nd B1 awrt 0.313 (calc gives 0.3133742...)
	1st M1 Recognize Binomial 1st A1ft writing B(4, 'their 0.313') May be $\Rightarrow$ by next line
	2nd dM1 (dep. on 1st M1) $C_1^4 \times$ 'their 0.3134' $\times$ (1 − 'their 0.3134')^3 2nd A1 awrt 0.406
(c)	1st M1 continuity correction used. Either 25.5 or 26.5
	2nd M1 standardising using their λ and $\sqrt{\lambda}$ for mean and sd. Any letter may be used or $\frac{x}{25}$ etc
	1st A1 $\dfrac{25.5 - \lambda}{\sqrt{\lambda}} = z$ where $0 < z < 0.5$ May be implied by their correct quadratic (25.5 req'd)
	B1 0.1 (calc 0.09992..) used as their z value in an equation. Allow e.g. $\frac{26-\mu}{\sigma} = 0.1$
	3rd dM1 (dep on 2nd M1) some attempt at solving their 3TQ $\frac{-b \pm \sqrt{+ve}}{2a}$ 2nd A1 25 (o.e.)
	4th dM1 (dep on 3rd M1) $\dfrac{\text{their } 25}{2} \times 50$ (If using $\frac{x}{25}$ award when x =..) 3rd A1 awrt 625

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