GradeMax

Pearson

Mark Scheme (Results)

Summer 2026

Pearson Edexcel International Advanced Level

In Statistics S3 (WST03) Paper 01

GradeMax

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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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- 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 and can be used if you are using the annotation facility on ePEN:
   - 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)
   - d… or dep – dependent
   - indep – independent
   - dp – decimal places
   - sf – significant figures
   - * – The answer is printed on the paper or ag- answer given
   - $\sqsubset$ or d… – 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. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

6. If a candidate makes more than one attempt at any question:
   a) If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   b) If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

Question Number	Scheme	Marks
1(a)	$\sum d^2 = 1+1+4+1+0+1+0+9+1[=18]$	M1
	$r_s = 1-\dfrac{6\times'18'}{9\left(9^2-1\right)} = 0.85$	M1A1
		(3)
(b)	$H_0 : \rho = 0 \qquad H_1 : \rho > 0$	B1
	Critical Value $r_s = 0.6$ or CR: $r_s \geqslant 0.6$	B1
	Reject H_0 or significant or does lie in the critical region	M1
	There is evidence to suggest that there is a **positive relationship** between the position in the 100 m freestyle and the position in the 200 m freestyle	A1
		(4)
(c)	The value of n will decrease	B1
	$\sum d^2$ would decrease/the difference in ranks for C and H would decrease [So SRCC will increase]	B1
		(2)

	Notes	**Total 9**
(a)	**M1**	for finding the difference between the position in the 100 m freestyle and the 200 m freestyle and evaluating $\sum d^2$. May be implied by 18. (Allow one error)
	M1	for using $1-\dfrac{6\sum d^2}{9\left(9^2-1\right)}$ with their $\sum d^2$
	A1	Cao **NB** 0.85 scores 3/3 (unless from obvious incorrect working)
(b)	**B1**	for both hypotheses correct. Must be in terms of ρ or ρ_s. Must be attached to H_0 and H_1 Condone use of p
	B1	for CV of 0.6
	M1	a correct statement ft part (a) and their CV – no context needed but do not allow contradicting non contextual statements. This may be implied by a correct contextual conclusion on its own. If part a not answered and/or no CV stated then M0
	A1	A correct contextual conclusion which is rejecting H_0. Allow there is **positive correlation** or a description of the relationship e.g. The higher the position in 100 m race the higher the position in the 200 m race oe
(c)	**B1**	For a correct comment about n decreasing e.g. $n\left(n^2-1\right)$ decreases **NB This is M1 on epen**
	B1	a correct explanation about what would happen to $\sum d^2$ or a comment about the difference in ranks for C and H **NB This is A1 on epen**

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>$\frac{115\times130}{250}=59.8$</td><td>M1A1</td></tr>
<tr><td></td><td></td><td>(2)</td></tr>
<tr><td>(b)</td><td>H_0 : There is no association between salary and university education
H_1 : There is an association between the salary and university education</td><td>B1</td></tr>
<tr><td></td><td><table><tr><th>Observed</th><th>Expected</th><th>$\frac{(O-E)^2}{E}$</th></tr><tr><td>52</td><td>“59.8”</td><td>$\frac{(52-"59.8")^2}{"59.8"}=1.017...$</td></tr></table></td><td>M1</td></tr>
<tr><td></td><td>$\sum\frac{(O-E)^2}{E}=2.908+"1.017"=3.925$</td><td>M1A1</td></tr>
<tr><td></td><td>$\nu=(2-1)(2-1)=1$</td><td>B1</td></tr>
<tr><td></td><td>$\chi^2_1(0.05)=3.841\Rightarrow$ CR: $X^2\geqslant 3.841$</td><td>B1ft</td></tr>
<tr><td></td><td>[In the CR/Significant/Reject H_0] There is evidence of an association between the salary and education</td><td>A1ft</td></tr>
<tr><td></td><td></td><td>(7)</td></tr>
<tr><td></td><td colspan="2">Notes</td><td>Total 9</td></tr>
<tr><td>(a)</td><td>M1</td><td>for use of $\frac{\text{Row total}\times\text{Column total}}{\text{Total}}$ May be implied by 59.8</td></tr>
<tr><td></td><td>A1</td><td>Cao</td></tr>
<tr><td>(b)</td><td>B1</td><td>both hypotheses correct with salary and education. May be written in terms of independence</td></tr>
<tr><td></td><td>M1</td><td>for use of $\frac{(O-E)^2}{E}$ ft their expected value in part (a) May be implied by 3.925 or 3.93</td></tr>
<tr><td></td><td>M1</td><td>for 2.908 + 1.017 ft their $\frac{(O-E)^2}{E}$ May be implied by 3.925 or 3.93</td></tr>
<tr><td></td><td>A1</td><td>for 3.925 Allow 3.93</td></tr>
<tr><td></td><td>B1</td><td>$\nu=1$ Implied by 3.841</td></tr>
<tr><td></td><td>B1ft</td><td>for 3.841 or ft their DoF [For reference $\nu=2$: 5.991 $\nu=3$: 7.815 $\nu=4$: 9.488]</td></tr>
<tr><td></td><td>A1ft</td><td>This mark is independent of the hypotheses. The conclusion must be consistent for the correct hypotheses.
For a correct contextual conclusion ft their $\sum\frac{(O-E)^2}{E}$ and their CV.
Must include salary and education. May be in terms of independence.</td></tr>
</table>

Question Number	Scheme	Marks
3(a)	$\left[\ \bar{y} = \frac{3780}{90} \Rightarrow\right]\ \bar{y} = 42$	B1
	$\left[s_y^{\ 2} =\right] \frac{164599.29 - 90(42)^2}{90-1}$	M1
	$= 65.61$	A1
		(3)
(b)	$H_0 : \mu_W - \mu_E = 0 \qquad H_1 : \mu_W - \mu_E < 0$	B1
	$z = \frac{40 - "42" - 0}{\sqrt{\frac{18.49}{90} + \frac{"65.61"}{90}}}$	M1A1ft
	$= -2.0689\ldots$	A1
	One tailed CV: $Z = -1.6449$ **or** CR: $Z \leqslant -1.6449$	B1
	In CR/Significant/Reject H_0	M1
	Sufficient evidence to support the **zoologist's claim**	A1ft
		(7)
(c)	Assumed that $s^2 = \sigma^2$ for **both** samples	B1
		(1)

	Notes	**Total 11**
(a)	**B1**	for $\bar{y} = 42$
	M1	a correct method for finding an unbiased estimate of the variance e.g. $\frac{\Sigma y^2 - n(\bar{y})^2}{n-1}$
	A1	Cao
(b)	**B1**	both hypotheses correct. Allow equivalent hypotheses. Must be in terms of μ Allow other letters e.g. μ_x and μ_y
	M1	an attempt at $\frac{a-b-0}{\sqrt{\frac{c}{90} + \frac{d}{90}}}$ with at least 2 of a, b, c or d correct. Allow ±
	A1ft	$z = \frac{40 - "42" - 0}{\sqrt{\frac{18.49}{90} + \frac{"65.61"}{90}}}$ Allow ±
	A1	awrt –2.07 (Allow awrt 2.07)
	B1	1.6449 or better seen
	M1	A correct statement ft their test statistic and their CV – need not be contextual but do not allow contradicting non contextual comments. May be implied by a correct contextual statement on its own
	A1ft	A correct contextual statement ft their test statistic and their CV. Must contain zoologist's claim (allow belief) or a correct conclusion based on the zoologists claim with **weight**, **Western** and **Eastern** e.g. the [mean] **weight** of **Western** [grey kangaroos] is less than **Eastern** [grey kangaroos]
(c)	**B1**	for the assumption that sample variance = population variance for **both** samples

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>$\mathrm{B}\left(4,\frac{1}{6}\right)$</td><td>B1
(1)</td></tr>
<tr><td>(b)</td><td>$\mathrm{H}_0:\mathrm{B}\left(4,\frac{1}{6}\right)$ is a good model $\quad$ $\mathrm{H}_1:\mathrm{B}\left(4,\frac{1}{6}\right)$ is not a good model</td><td>B1</td></tr>
<tr><td></td><td>$\mathrm{E}(X=0)=\left(\frac{5}{6}\right)^4\times 200=96.4506...$ $\quad$ $\mathrm{E}(X=1)=4\times\left(\frac{5}{6}\right)^3\times\left(\frac{1}{6}\right)\times 200=77.1604...$
$\mathrm{E}(X=2)=6\times\left(\frac{5}{6}\right)^2\times\left(\frac{1}{6}\right)^2\times 200=23.1481...$
$\mathrm{E}(X=3)=4\times\left(\frac{5}{6}\right)\times\left(\frac{1}{6}\right)^3\times 200=3.0864...$ $\quad$ $\mathrm{E}(X=4)=\left(\frac{1}{6}\right)^4\times 200=0.15432...$</td><td>M1M1A1</td></tr>
<tr><td></td><td><table><tr><th>O</th><th>E</th><th>$\frac{(O-E)^2}{E}$</th><th>$\frac{O^2}{E}$</th></tr><tr><td>110</td><td>96.45</td><td>1.9036…</td><td>125.4…</td></tr><tr><td>64</td><td>77.16</td><td>2.2444…</td><td>53.0…</td></tr><tr><td>26</td><td>26.39</td><td>0.005473…</td><td>25.6…</td></tr></table></td><td>M1M1</td></tr>
<tr><td></td><td>$\sum\frac{(O-E)^2}{E}=4.153...$ or $\sum\frac{O^2}{E}-200=4.153...$</td><td>A1</td></tr>
<tr><td></td><td>$\nu=2$ CR: $\chi^2>9.21$</td><td>B1B1ft</td></tr>
<tr><td></td><td>Insufficient evidence that $\mathrm{B}\left(4,\frac{1}{6}\right)$ is not a good model</td><td>dA1</td></tr>
<tr><td></td><td></td><td>(10)</td></tr>
<tr><td>(c)(i)</td><td>Use the data to estimate p/ p may not be $\frac{1}{6}$</td><td>B1</td></tr>
<tr><td>(ii)</td><td>Degrees of freedom reduced by 1 or critical value will decrease/critical region will increase</td><td>B1</td></tr>
<tr><td></td><td></td><td>(2)</td></tr>
<tr><td></td><td colspan="2">Notes</td><td>Total 13</td></tr>
<tr><td>(a)</td><td>B1</td><td colspan="2">binomial with $n = 4$ and $p=\frac{1}{6}$</td></tr>
<tr><td>(b)</td><td>B1</td><td colspan="2">both hypotheses correct. $\mathrm{B}\left(4,\frac{1}{6}\right)$ only needs to be mentioned once. Condone H_0 : Binomial is a suitable model H_1 : Binomial is not a suitable model provided $p=\frac{1}{6}$ is seen in part (a)</td></tr>
<tr><td></td><td>M1</td><td colspan="2">a correct binomial probability seen (May be implied by a correct expected value)</td></tr>
<tr><td></td><td>M1</td><td colspan="2">a correct method to find an expected value (May be implied by a correct expected value)</td></tr>
<tr><td></td><td>A1</td><td colspan="2">At least 4 expected values correct to 3 significant figures or better</td></tr>
<tr><td></td><td>M1</td><td colspan="2">for combining (2, 3 and 4) to ensure that all expected frequencies are > 5 May be implied by awrt 4.15</td></tr>
<tr><td></td><td>M1</td><td colspan="2">for a correct method to find either $\frac{(O-E)^2}{E}$ or $\frac{O^2}{E}$ (May be implied by a correct value)</td></tr>
</table>

	A1	for awrt 4.15
	B1	for DoF = 2
	B1ft	for a correct CV ft their DoF [For reference $\nu = 1$: 6.635 $\nu = 3$: 11.345 $\nu = 4$: 13.277]
	dA1	Dep on 3rd M mark. For a correct conclusion. Allow Binomial is a good model
(c)(i)	**B1**	correct comment about p e.g. p will be 0.1587… (allow awrt 0.159)
(ii)	**B1**	correct comment about the **reduction** in DOF oe e.g. Degrees of freedom will decrease. Allow DOF = 1 if DOF was 2 in their test or a correct comments about the critical value/critical region Allow CV = 6.635 if CV was 9.210 in their test

Question Number	Scheme	Marks
5(a)	$\left[\dfrac{24.7034+26.8966}{2}=\right]25.8$	B1 (1)
(b)	$26.8966-24.7034=2\times1.6449\times\dfrac{\sigma}{\sqrt{36}}$ oe or $26.8966-"25.8"=1.6449\times\dfrac{\sigma}{\sqrt{36}}$ oe or $"25.8"-24.7034=1.6449\times\dfrac{\sigma}{\sqrt{36}}$ oe	M1B1
	$\dfrac{6(26.8966-24.7034)}{2(1.6449)}=\sigma$ oe or $\dfrac{6(26.8966-25.8)}{1.6449}=\sigma$ oe or $\dfrac{6(25.8-24.7034)}{1.6449}=\sigma$ oe or $\dfrac{3.2898}{6}\sigma=2.1932$ oe or $\dfrac{\sigma}{6}=\dfrac{2}{3}$ oe leading to $\sigma=4$*	A1*
		(3)
(c)	$2\times z\times\dfrac{4}{\sqrt{36}}=1.6$ oe	M1
	$z=1.2$	A1
	$\mathrm{P}(Z>1.2)=0.1151$ or $\mathrm{P}(Z<1.2)=0.8849$	M1
	Confidence level = $100\times(1-2\times0.1151)$ or $100\times(2\times0.8849-1)$	M1
	= 77 awrt 77	A1
		(5)
(d)	$2\times1.6449\times\dfrac{4}{\sqrt{n}}<0.6$ oe	M1
	$\sqrt{n}>\dfrac{8\times1.6449}{0.6}\left[\Rightarrow\sqrt{n}=21.932\right]$ or $\sqrt{n}>\dfrac{8\times1.64485...}{0.6}\left[\Rightarrow\sqrt{n}=21.9313...\right]$	dM1
	n = 481.01… so n = 482 or n = 480.98… so n = 481	A1
		(3)
	Notes	**Total 12**

Mark parts (a) and (b) together

(a)	**B1**	Cao
(b)	**M1**	for $26.78-24.82=2\times z$ value$\times\dfrac{\sigma}{\sqrt{36}}$ oe or $26.78-"25.8"=z$ value$\times\dfrac{\sigma}{\sqrt{36}}$ oe or $"25.8"-24.82=z$ value$\times\dfrac{\sigma}{\sqrt{36}}$ oe ft their 25.8
	B1	1.6449 or better
	A1*cso	at least one line of working from M1 to the given answer with no incorrect working seen (Allow 4.00)
(c)	**M1**	for $2\times z\times\dfrac{4}{\sqrt{36}}=1.6$ may be implied by z = 1.2
	A1	z = 1.2
	M1	for $\mathrm{P}(Z>1.2)=0.1151$ or $\mathrm{P}(Z<1.2)=0.8849$ ft their z may be implied by 0.7699 or awrt 77

	M1	for $100\times(1-2\times0.1151)$ ft their 0.1151 or $100\times(2\times0.8849-1)$ ft their 0.8849 May be implied by awrt 77
	A1	Awrt 77
(d)	**M1**	for $2\times z$ value $\times\frac{4}{\sqrt{n}}<0.6$ z value must either be correct or consistent with part (b) Condone = or $\leqslant$
	dM1	dependent on previous M mark. Correct rearrangement to get $\sqrt{n}>...$ or $n>\ldots$ Condone = or $\geqslant$
	A1	$n = 482$ or $n = 481$ (Must be clear that their answer matches their working)

Question Number	Scheme	Marks
6(a)	[Continuous] uniform on the interval [0, 15]	B1
		(1)
(b)	mean = 7.5	B1
	standard deviation = $\sqrt{\frac{(15-0)^2}{12}}$	M1
	$\frac{15}{\sqrt{12}} = 4.330...$	A1
		(3)
(c)	By the CLT $\overline{T} \sim \mathrm{N}\left(7.5,\ \frac{3}{8}\right)$	M1
	$\mathrm{P}\left(7.2 < \overline{T} < 7.8\right) = \mathrm{P}\left(\frac{7.2-"7.5"}{\sqrt{"\frac{3}{8}"}} < Z < \frac{7.8-"7.5"}{\sqrt{"\frac{3}{8}"}}\right) = \left[\mathrm{P}\left(-0.49 < Z < 0.49\right)\right]$	M1A1
	= 0.6879 – (1 – 0.6879) (Calculator gives 0.68789…)	M1
	= 0.3758 (Calculator gives 0.37579…) awrt 0.376	dA1
		(5)
	Notes	**Total 9**

(a)	**B1**	for the correct distribution stated (need uniform and correct interval) Allow U[0, 15] Condone U(0, 15) Must be seen in part (a)
(b)	**B1**	Cao
	M1	for a correct method for finding the standard deviation
	A1	awrt 4.33 Condone $\frac{5\sqrt{3}}{2}$
(c)	**M1**	for writing or using $\mathrm{N}\left(7.5,\ \frac{3}{8}\right)$ oe May be seen in a correct standardisation
	M1	for standardising using either 7.2 or 7.8 and their mean and standard deviation. The standardisation must be shown for this mark
	A1	for a fully correct expression for either 7.2 or 7.8. May be implied by ± awrt 0.49
	M1	for $p - (1 - p)$ or $2(p - 0.5)$ oe
	dA1	Dep on 2nd M mark for awrt 0.376

Question Number	Scheme	Marks
7(a)	$\mathrm{E}(C) = 4\mu - 3\mu - \mu [= 0]$	M1
	$\mathrm{Var}(C) = 16\sigma^2 + 9\sigma^2 + \frac{\sigma^2}{3}\left[= \frac{76\sigma^2}{3}\right]$	M1
	$\mathrm{N}\left(0, \frac{76\sigma^2}{3}\right)$	A1
		(3)
(b)	$\mathrm{P}\left(Z < \frac{\sigma - "0"}{\sqrt{"\frac{76\sigma^2}{3}"}}\right)$	M1A1
	= 0.5793 Calc: 0.5787 awrt 0.579	dA1
		(3)
(c)	$4W_1 - 3W_2 - \bar{W} = \frac{11W_1 - 10W_2 - W_3}{3}$	M1
	$\mathrm{E}(Q) = 0$	B1
	$\mathrm{Var}(Q) = \frac{121\sigma^2 + 100\sigma^2 + \sigma^2}{9}\left[= \frac{222\sigma^2}{9} = \frac{74\sigma^2}{3}\right]$	M1
	$\mathrm{P}\left(Z < \frac{2\sigma - 0}{\sqrt{\frac{74\sigma^2}{3}}}\right)$	M1A1
	= 0.6554 Calc: 0.6564… awrt 0.655 – awrt 0.656	dA1
		(6)

	Notes	**Total 12**
(a)	**M1**	for a correct method to find E(C). May be implied by E(C) = 0
	M1	for a correct method to find Var(C). May be implied by Var(C) = $\frac{76\sigma^2}{3}$
	A1	Cao
(b)	**M1**	for standardising ft their mean and their standard deviation. Allow ± May be implied by ± awrt 0.199
	A1	for a fully correct standardisation using 0 and $\frac{76\sigma^2}{3}$ Allow ±May be implied by ± awrt 0.199
	dA1	dependent on previous A1 awrt 0.579
(c)	**M1**	for writing Q as a single fraction (May be implied by 2nd M1) Allow $4W_1 - 3W_2 - \frac{1}{3}W_1 - \frac{1}{3}W_2 - \frac{1}{3}W_3$ oe
	B1	for E(Q) = 0 May be seen in a standardisation
	M1	for a correct method to find Var(Q) May be seen in a standardisation. May be implied by Var(Q) = $\frac{74\sigma^2}{3}$
	M1	for standardising using 0 and their standard deviation

	A1	for a fully correct standardisation using 0 and $\frac{74\sigma^2}{3}$ oe
	dA1	Dependent on the previous A mark. For answer in the range awrt 0.655 to awrt 0.656