Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Level
In Statistics 1
(WST01/01)

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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.
- 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.

- 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
- ⌐ 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.

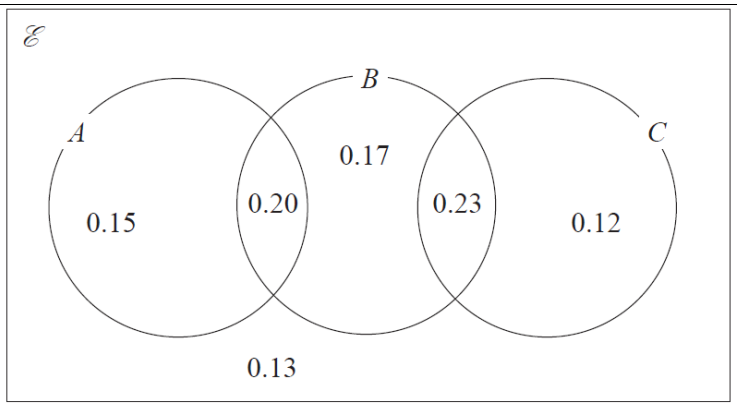
5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

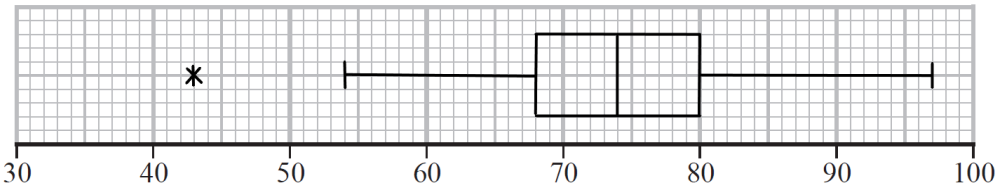
6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark the last most complete solution.

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

Question Number	Scheme	Marks
1 (a)	[0.15 + 0.13 + 0.12 =] **0.4**	B1 (1)
(b)	0.15 + 0.20 + 0.23 + 0.12 or 1 – (0.17 + 0.13) or 0.35 + 0.35 = **0.7**	M1 A1 (2)
(c)	$\left[\mathrm{P}(A \mid B') =\right] \frac{\mathrm{P}(A \cap B')}{\mathrm{P}(B')}$ and $\frac{p}{"0.4"}$ or $\frac{0.15}{"0.4"}$ = $\frac{3}{8}$	M1 A1 (2) **[5 marks]**

	Notes
(a)	B1 for 0.4 or exact equivalent
(b)	M1 for a correct sum or expression A1 for 0.7 or an exact equivalent. Correct answer with no incorrect working 2/2
(c)	M1 for $\frac{\mathrm{P}(A \cap B')}{\mathrm{P}(B')}$ **and** $\frac{p}{"0.4"}$ where $0 < p <$ "0.4" or just $\frac{0.15}{"0.4"}$ Condone one missing "P" e.g. $\frac{\mathrm{P}(A \cap B')}{(B')}$ but NOT $\mathrm{P}\left(\frac{A \cap B'}{B'}\right)$ or $\frac{A \cap B'}{B'}$ but of course they may score this M mark from $\frac{0.15}{"0.4"}$ A1 for $\frac{3}{8}$ or exact equivalent e.g. 0.375 but $\frac{0.15}{0.4}$ is A0 Correct answer with no incorrect working 2/2



Question Number	Scheme	Marks
2. (a)	[Median =] **74**	B1 (1)
(b)	$Q_1 = 68$ $Q_3 = 80$ [IQR = 80 – 68 =] **12**	M1 A1 (2)
(c)	$Q_1 - 1.5\times(\text{IQR}) = "68" - 1.5\times "12"$ [= **50**] or $Q_3 + 1.5\times(\text{IQR}) = "80" + 1.5\times "12"$ [=**98**] Outliers are < **50** or > **98** So there is just one outlier at **43**	M1 A1ft A1 (3)
(d)		M1 A1ft A1 (3) **[9 marks]**

	Notes
(a)	B1 for 74
(b)	M1 for an attempt at both and at least one correct. May be in a calculation e.g. 80 – A (where 60 < A < 80) or B – 68 (where 68 < B < 90) A1 for 12
(c)	M1 for correct attempt for at least one of the limits. Can ft their quartiles and IQR 1st A1ft for correct attempts for **both** limits and with at least one correct limit or correct ft using their quartiles and IQR Sight of the two limits 50 and 98 will score M1A1 2nd A1 for identifying only one outlier at 43 (e.g. may say "43 < 50") Must be stated in (c) Just stating the outlier is 43 (or seeing it on box plot) without sight of limits is M0A0A0
(d)	M1 for drawing a box with only two whiskers one at each end 1st A1ft for Q_1, Q_2 and Q_3 as a correctly drawn box (or ft their values for $Q_1 < Q_2 < Q_3$) 2nd A1 for upper whisker ending at 97 **and** lower whisker ending at 54 or 50 **and** only one outlier, shown at 43 Allow ± 0.5 of a square for accuracy **NB** A fully correct box plot can score full marks in (d) even if other parts are missing or incorrect

Question Number	Scheme	Marks
3. (a)	[W = weight of a package delivered to factory $W \sim N(18, 5.4^2)$]	
	$P(W < 18) = P\left(Z < \frac{10-18}{5.4}\right)$ <u>or</u> $P(Z < -1.481\ldots)$	M1
	$= 1 - 0.9306$ (calc: 0.069239…)	M1
	$= 0.0694$ **<u>[0.0692, 0.0694]</u>**	A1
		(3)
(b)	[$P(W > j) = 0.15$ implies] $\frac{j-18}{5.4} = 1.0364$	M1B1
	$j = 23.596\ldots$ awrt **<u>23.6</u>**	A1
		(3)
(c)	[$P(W > 18 \mid W <$ "23.59…") =] $\frac{P(18 < W < "23.6")}{P(W < "23.6")}$	M1
	$= \frac{0.5-0.15}{0.85}$ <u>or</u> $\frac{0.85-0.5}{0.85}$; $= \frac{0.35}{0.85}$	M1;A1
	$= \frac{35}{85} = \underline{\underline{\frac{7}{17}}}$ or allow awrt **<u>0.412</u>**	A1
		(4)
(d)	$0.85^2 \times 0.15^2 \times 6$	M1dM1
	$= 0.0975375$ awrt **<u>0.0975</u>**	A1
		(3)
		[13 marks]

	Notes
(a)	1st M1 for standardising 10 with 18 and 5.4 (allow <u>±</u>) 2nd M1 for $1 - p$ (where $0.91 < p < 0.95$) A1 for answer in the range $0.0692 \leqslant$ ans $\leqslant 0.0694$ (calc. 0.069239…) **Ans only 3/3**
(b)	M1 for standardising their letter j with 18 and 5.4 and setting equal to z value $1 < \lvert z \rvert < 2$ Condone use of 10 instead of 18 for the M1 mark B1 for use of $z = \pm 1.0364$ or better (calc 1.03643338…) A1 for awrt 23.6 (calc 23.596740.…) **Ans only** [awrt 23.60 scores 3/3 23.6 scores M1B0A1 unless 1.0364 or better is seen]
(c)	1st M1 for a correct ratio of probability expressions ft their answer to (b) i.e. their j either the letter or their value provided > 18 May be implied by 2nd M1 2nd M1 for a ratio of probs of the form $\frac{q}{0.85}$ where $0.15 < q < 0.5$ Allow recalculation of 0.85 provided awrt 0.85 1st A1 for a correct ratio i.e. using $q = 0.35$ 2nd A1 for $\frac{7}{17}$ or exact equivalent or allow awrt 0.412 (0.4117647…)
(d)	1st M1 for $p^2 \times (1-p)^2 \times k$ for any positive integer k (allow $k = 1$) and any probability p 2nd dM1 dep on 1st M1 for $k = 6$ <u>or</u> 3! <u>or</u> 3×2 <u>or</u> 4C2 A1 for awrt 0.0975 NB allow exact fraction $\frac{7803}{80000}$ **Ans only 3/3**

Question Number	Scheme	Marks
4 (a)	(Discrete) uniform (distribution)	B1 (1)
(b)(i)	[By symmetry] E(X) = **13**	B1 (1)
(ii)	$\frac{10^2+12^2+14^2+16^2}{4}-13^2$ or $\frac{696}{4}-169$ or $174-169$	M1
	= **5**	A1 (2)
(c)(i)	E(Y) = $\frac{1}{30}(1\times4+2\times9+3\times6+4\times5+5\times6)$; $=\frac{90}{30}$ = **3**	M1; A1 (2)
(ii)	E(Y^2) = $\frac{1}{30}(1^2\times4+2^2\times9+3^2\times6+4^2\times5+5^2\times6)=\left[\frac{324}{30}\text{ or }10.8\right]$	M1
	Var(Y) = "10.8" – "[3]"^{2} ; = **1.8**	M1; A1 (3)
(d)	E(W) = E(Y) $\Rightarrow$ aE(X) + b [= E(W) or E(Y) or "3"]; i.e. "13"$a+b$="3"	M1; A1ft
	Var(W) = Var(Y) $\Rightarrow$ $a^2\times$"5"="1.8"; so $a=\frac{3}{5}$ or **0.6**	M1; A1
	b = **– 4.8**	A1 (5)
(e)	Values of w are: $10\times$"0.6"–"4.8" = 1.2 or 2.4 or 3.6 or 4.8 i.e. all non integers	M1
	[So no cases are possible when $W = Y$ so P($W = Y$)] = **0**	A1 (2)
		[16 marks]

Notes

(a) B1 for "uniform" but if they say "continuous uniform" B0

For all parts, correct answer with no incorrect working seen scores full marks

(b)(i) B1 for 13

(ii) M1 for a fully correct expression, can ft their 13 May use E($X-\mu$)^2 = $\frac{3^2\times2+1^2\times2}{4}$

A1 for 5

(c)(i) M1 for an attempt at E(Y) with at least 3 correct products seen

A1 for 3

(ii) 1st M1 for an attempt at E(Y^2) with at least 3 correct products seen or 10.8 o.e.

2nd M1 for correct expression for Var(Y) (ft their 10.8 and 3) [NB Var(Y) = …= 10.8 M1M0]

A1 for 1.8 (or exact equivalent)

E($X-\mu$)^2 May see $0\times\frac{6}{30}+1\times\left(\frac{9}{30}+\frac{5}{30}\right)+2^2\times\left(\frac{4}{30}+\frac{6}{30}\right)$ if in doubt send to review.

(d) 1st M1 for correct use of E($aX + b$) formula i.e. aE(X) + b or "13" $a + b$

1st A1ft for a correct equation in a and b ft their E(X) and their E(Y)

2nd M1 for correct use of Var(Y) = Var($aX + b$) formula with their Var(X) and their Var(Y)

2nd A1 for a = 0.6 or exact equivalent

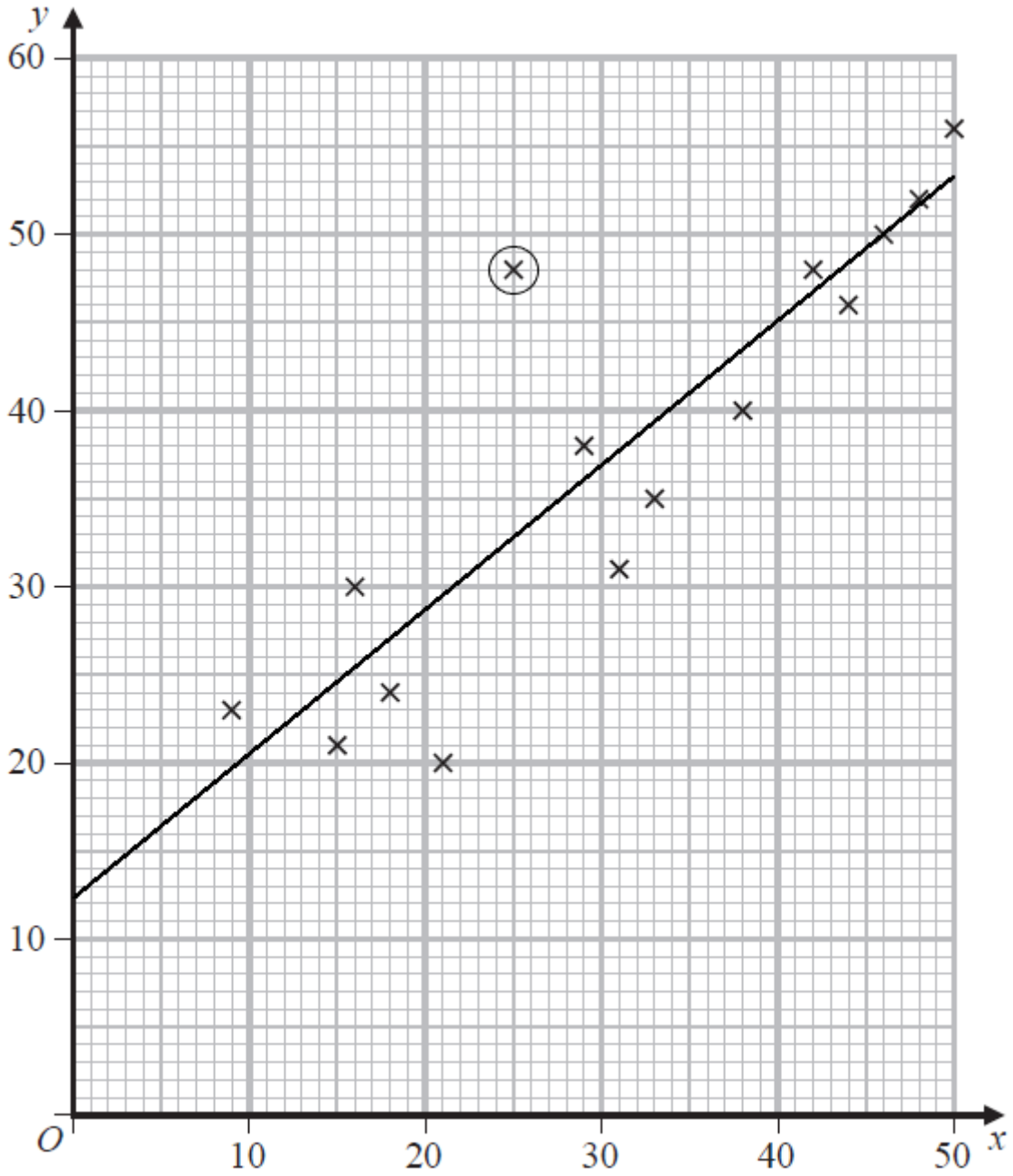
3rd A1 for b = – 4.8 or exact equivalent

(e) M1 for a clear attempt to find **all** possible values of w (ft their values of a and b and w values needn't be correct) or state that **no integer** values for w (if this is true)
Can ft their values of a and b even if the values for w are integers

A1 for an answer of 0 provided it's true for their a and b (which may be incorrect)

Question Number	Scheme	Marks
5 (a)	Positive (correlation) or e.g. "salary (y) increases as performance (x) increases" [NB "Positive skew" is B0]	B1 (1)
(b)(i)	$19\,428 - \frac{465\times562}{15}$ or $19\,428 - \frac{261330}{15} = 2006$ **(*)**	B1cso (1)
(ii)	$\left[S_{yy} =\right]\quad 23140 - \frac{562^2}{15}$	M1
	$= 2083.7333\ldots$ awrt **2080**	A1 (2)
(c)	$\left[r =\right]\frac{2006}{\sqrt{2492\times"2083.73.."}}$; $= 0.8803104\ldots$ awrt **0.880**	M1;A1 (2)
(d)	Is consistent **and** the points on the scatter diagram lie close to a straight line or r is close to 1 or strong/high (positive) correlation (o.e.)	B1 (1)
(e)	$b = \frac{2006}{2492}$; $= 0.80[497\ldots]$; $a = 37.46... - "b"\times 31$ [$= 12.512\ldots$]	M1;A1;M1
	$y = 12.5 + 0.805x$	A1 (4)
(f)	An increase of 1 (performance) point gives an extra £800 (1 sf) in salary (o.e.)	B1 (1)
(g)	**Line must cross $x = 9$ and $x = 50$ to score either of these marks**	
	Line for 9~50 Intercept (extend line if necessary) at "12.5" (accept 11.5~13.5)	B1ft
	Line for 9~50 At $x = 50$ $y = 52.8$ (accept 52~54)	B1 (2)
(h)	For the point (25, 48) circled. (If more than one of the given points circled B0)	B1 (1)
(i)	$"12.5"+30\times"0.805"$ [= 36 ~37] or allow 2sf from their diagram	M1
	Salary of awrt (£) **36 700** (or 36.7 thousands)	A1 (2) **[17 marks]**

	Notes
(b)(i)	B1 for correct expression, all correct values must be seen (either of the printed expressions)
	Correct answers to parts (b)(ii), (c), (e) & (i) with no incorrect working score full marks
(ii)	M1 for a correct expression A1 for awrt 2080 (expect to see 2084 but allow $\frac{31256}{15}$)
(c)	M1 for a correct expression but ft their $S_{yy} \neq 23140$ or answer only of 0.88 A1 for awrt 0.880 (accept 0.88 from a correct expression with $S_{yy} = [2083 \sim 2084]$)
(d)	B1 [no ft] for "yes" (o.e.) **and** a suitable reason based on scatter diagram or value of r
(e)	1st M1 for a correct expression for b 1st A1 for $b = 0.80$ or better (allow $\frac{1003}{1246}$ but not $\frac{2006}{2492}$) 2nd M1 for a correct expression for a (allow $\frac{562}{15}$ for 37.46… and $\frac{465}{15}$ for 31) 2nd A1 for correct equation in y and x with b = awrt 0.805 and a = awrt 12.5(no fractions)
(f)	B1 for a comment mentioning their value in £ of $b\times1000$ (awrt 1 sf) per performance point Condone use of $ rather than £
(g)	1st B1ft for correct intercept for their line (± 1) 2nd B1 for $y = 52\sim54$ when $x = 50$
(i)	M1 for using $x = 30$ in their equation ft their a and b to any accuracy A1 for awrt 36 700 (Answer only of awrt 37 000 can score M1A0)


y
60
50
40
30
20
10
O
10
20
30
40
50
x

Question Number	Scheme	Marks
6. (a)	Centre of the disc must land at least 1 cm from each side of the rectangle	M1
	i.e. inside a rectangle 3 cm long and 1 cm wide	dM1
	Probability disc lies inside rectangle is $\frac{3\times1}{5\times3} = \frac{1}{5}$ or $1-\frac{2(1\times5+1\times1)}{5\times3}$ (oe) **(*)**	A1cso
		(3)
(b)	$[\sigma_x =]\sqrt{\frac{295}{15}-\left(\frac{61}{15}\right)^2}$ or $\sqrt{3.1288...}$	M1
	$= 1.768866\ldots$ awrt **1.77**	A1
		(2)
(c)	$\bar{y}=3.5 \Rightarrow \sum y = 42$, so new $\sum z = 42+61[=103]$	M1, A1
	$\sigma_y = 2 \Rightarrow 2^2 = \frac{\sum y^2}{12}-3.5^2$ or $2=\sqrt{\frac{\sum y^2}{12}-3.5^2}$	M1
	$\sum y^2 = (2^2+3.5^2)\times12$ [= 195] so new $\sum z^2 = (2^2+3.5^2)\times12+295$ [or 490]	A1
	New mean = $\frac{"103"}{(15+12)} = [3.8148...]$	dM1
	New standard deviation = $\sqrt{\frac{"490"}{(12+15)}-"3.81..."^2}$ [= 1.89613…]	dM1
	New mean =awrt **3.81** new st. dev = awrt **1.90**	A1
		(7)
(d)	Centre of disc must be within 1 cm of a vertex (so 4 quarter circles)	M1
	So probability of disc covering a vertex is $\frac{\pi}{15}$	A1
	So an estimate for π is 15×0.2216 = **3.324**	A1
		(3)
		[15 marks]

	Notes
(a)	1st M1 accept a suitable diagram showing "winning area" or equivalent in words 2nd dM1 dep on M1 for dimensions of rectangle within which centre must lie (at least 3 or 1 seen) A1 cso for complete explanation **with evidence seen** for both M1 marks
MR	**See next page for case of MR with *n* = 15×20 = 300**
(b)	M1 for a correct expression including $\sqrt{}$ allow $\sqrt{3.129}$ or better A1 for awrt 1.77 [exact surd is A0] (allow *s* = awrt 1.83 [calc: 1.8309508…]) **Ans only 2/2**
(c)	1st M1 for using mean of 3.5 to get sum of 12 students e.g. 12×3.5 1st A1 for a correct sum of 42 + 61 or 103 (allow any letter). 2nd M1 for a correct equation for $\sum y^2$ (sum of squares for the 12 students). Any letter 2nd A1 for correct expression for $\sum z^2$ e.g. = 195 + 295 [= 490] 3rd dM1 dep on 1st M1 for a correct method for finding new mean or awrt 3.81 4th dM1 dep on 1st and 2nd M1s for a correct method for new st. dev. 3rd A1 for both mean = awrt 3.81 (or 3.815) and st. dev = awrt 1.90
(d)	M1 for explanation or diagram showing possible region for centre is a full circle 1st A1 for the correct probability. Allow M1A1 for $\frac{\pi}{15}$ (o.e.) but must be in part (d) 2nd A1 dep on M1 for estimate of 3.324 (accept 3.32 if M1A1 clearly scored)

	Minimum acceptable for 3/3 is $\pi = 15 \times 0.2216 = 3.324$

Qu 6	Scheme for MR	Marks
(a)	As for main scheme	M1dM1
MR	**Only use this scheme for marking the MR**	A1cso (3)
***n* = 300**		
(b)	$[\sigma_x =] \sqrt{\frac{295}{300} - \left(\frac{61}{300}\right)^2}$ or $\sqrt{0.941988..}$	M1
	= 0.9705611… awrt **0.971**	A0ft
***m* = 240**		(2 – 1 = 1)
(c)	$\bar{y} = 3.5 \Rightarrow \sum y = 240 \times 3.5 = 840$, so new $\sum z = 840 + 61 [= 901]$	M1, A0ft
	$\sigma_y = 2 \Rightarrow 2^2 = \frac{\sum y^2}{240} - 3.5^2$ or $2 = \sqrt{\frac{\sum y^2}{240} - 3.5^2}$	M1
	$\sum y^2 = \left(2^2 + 3.5^2\right) \times 240 [= 3900]$ so $\sum z^2 = \sum y^2 = (2^2 + 3.5^2) \times 240 + 295$ [or 4195]	A1ft
	New mean = $\frac{"901"}{(300+240)} = [1.66851...]$	dM1
	New standard deviation = $\sqrt{\frac{"4195"}{(240+300)} - "1.668..."^2}$ [= 2.2326…]	dM1
	New mean =awrt **1.67** new st. dev = awrt **2.23**	A1ft
		(7 – 1 = 6)
(d)	Centre of disc must be within 1 cm of a vertex (so 4 quarter circles)	M1
	So probability of disc covering a vertex is $\frac{\pi}{15}$	A1
	So an estimate for π is 15×0.2216 = **3.324**	A1
		(3)
		[13 marks]

	Notes
(a)	As in main scheme
(b)	M1 for a correct expression including $\sqrt{}$ allow $\sqrt{0.942}$ or better A0 for awrt 0.971 (This is A0 for misread as the first two accuracy ft marks are withheld)
(c)	1st M1 for using mean of 3.5 to get sum of 12 students e.g. 240×3.5 1st A0 for a correct sum of 840 + 61 or 901 (allow any letter) (This is the 2nd A0 for misread unless, of course, they didn't achieve awrt 0.971 in (b)) 2nd M1 for a correct equation for $\sum y^2$ (sum of squares for the 12 students = 240 rolls) 2nd A1ft for correct expression for $\sum z^2$ e.g. = 3900 + 295 [= 4195] 3rd dM1 dep on 1st M1 for a correct method for finding new mean or awrt 1.67 4th dM1 dep on 1st and 2nd M1s for a correct method for new st. dev. 3rd A1ft for both mean = 1.67 and st. dev = awrt 2.23
(d)	**As in main scheme** M1 for explanation or diagram showing possible region for centre is a full circle 1st A1 for the correct probability. Allow M1A1 for $\frac{\pi}{15}$ (o.e.) but must be in part (d) 2nd A1 dep on M1 for estimate of 3.324 (accept 3.32 if M1A1 clearly scored) Minimum acceptable for 3/3 is $\pi = 15 \times 0.2216$ = 3.324

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