Mark Scheme (Results)

Summer 2021

Pearson Edexcel International Advanced Level In Statistics S1 Paper 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.

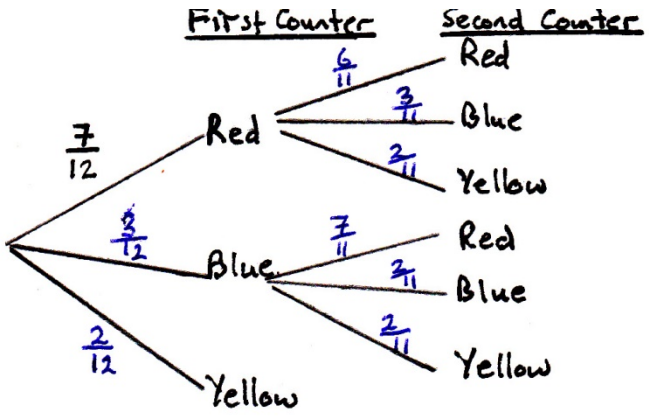
- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special 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.

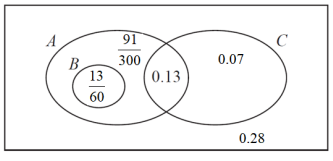
6. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer that is the most complete.

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

Question Number	Scheme	Marks
1. (a)		B1 B1 (2)
(b)	$P(Y) = \frac{7}{12}\times\frac{2}{11} + \frac{3}{12}\times\frac{2}{11} + \frac{2}{12} = \left\{\frac{42}{132} \text{ or } \frac{7}{22}\right\}$ **or**	
	$P(\text{Yellow and two counters}) = \frac{7}{12}\times\frac{2}{11} + \frac{3}{12}\times\frac{2}{11} = \left\{\frac{20}{132} \text{ or } \frac{5}{33}\right\}$	M1
	$\frac{P([Y\cap R]\cup[Y\cap B])}{P(Y)} = \frac{"\frac{20}{132}"}{"\frac{42}{132}"}$	M1
	$= \frac{20}{42}$ or $\frac{10}{21}$ oe	A1 (3) **[5 marks]**

	Notes	
(a)	1st B1	for the remaining probs on first set of branches and at least one on 2nd set
	2nd B1	for a fully correct tree diagram with all the correct probabilities
(b)	1st M1	for a correct ft expression for P(Y) or P(Yellow and two counters)ft their tree diagram eg $1-\frac{7}{12}\times\frac{6+3}{11}-\frac{3}{12}\times\frac{7+2}{11}$ **NB:** The method is implied by the numbers in curly brackets but we do not need to see them to award the mark.
	2nd M1	for a correct ratio formula (symbols or words) and at least one correct ft prob or fully correct ft ratio. Do not follow through probabilities > 1 or < 0
	A1	for $\frac{10}{21}$ or exact equivalent. (Allow $0.\dot{4}76190\dot{}$) **NB** if an exact correct fraction is not given and an awrt 0.476…. is given it would get M1M1A0 if from correct working Generally if the answer is correct then award full marks (unless from obvious incorrect working) or notes indicate otherwise

Question Number	Scheme	Marks
2. (a)	B and C	B1 (1)
(b)	A and C independent gives:	
	$\text{P}(C)\times 0.65 = 0.13$ **or** $0.65\times(r+0.13)=0.13$ **or** $0.65\times(0.48-s)=0.13$	M1
	$\text{P}(C)=0.2$ **or** $r+0.13=0.2$ **or** $0.48-s=0.2$	A1
	r {$= 0.2 - 0.13$} = **0.07** **or** s {$= 0.48 - 0.2$} = **0.28**	A1
	$\text{P}(A)+r+s=1$ **or** $0.65 + \text{"0.07"} + s = 1$ **or** $0.65 + \text{"0.28"} + r = 1$	M1
	s {$= 1 - 0.72$ =} **0.28** **and** r {$= 1 - 0.93$ =} **0.07**	A1 (5)
(c)	$\text{P}[(B\cup C)] = \text{"0.2"} + q$ **or** $0.13 + \text{"0.07"} + q$	B1ft
	$\text{P}(A\cap C') = p+q \quad \{=0.52\}$	B1
	$\{\text{P}[(A\cap C')\cap(B\cup C)]=q\Rightarrow\} \quad \text{"}(p+q)\text{"}\times\text{"}(0.2+q)\text{"}=q$ **or** $\text{"}(p+q)\text{"}\times\text{"}(0.13+\text{"0.07"}+q)\text{"}=q$ or $\text{"}(p+q)\text{"}\times\text{"}(1-s-p)\text{"}=0.52-p$	M1
	[Using $p+q=0.52$] $0.52\times\text{"}(0.2+q)\text{"}=q$ or $0.52(0.72-p)=0.52-p$	M1
	$q=\frac{13}{60}$	A1
	$p=\frac{91}{300}$	A1 (6)
	Notes	**[12 marks]**
(a)	B1 B and C seen. If they include A then B0	
(b)	1st M1 for a correct equation for P(C) using independence.	
	1st A1 for P(C) = 0.2 correct linear equation for r or s	
	2nd A1 for either $r = 0.07$ or $s = 0.28$	
	2nd M1 for using $\sum p = 1$ Allow letter r and s or their values for r and s provided they are probabilities.	
	3rd A1 for both $s = 0.28$ and $r = 0.07$	
	NB: The quotations around the 0.07 ("0.07") imply that we ft their value	
(c)	1st B1ft for an expression (in q) for $\text{P}(B\cup C)$ ft their value of r or their "0.2" eg 0.13 + "their r" + q Implied by 1st or 2nd M1 below.	
	2nd B1 for a correct expression for $\text{P}(A\cap C')$ in terms of p and q or 0.52 Implied by 1st or 2nd M1below	
	1st M1 for a correct use of independence (ft their probabilities), values or letters. Implied by 2nd M1	
	2nd M1 using $p + q = 0.52$ to gain a linear equation in one variable	
	1st A1 for a correct fraction for q	
	2nd A1 for a correct fraction for p	
	SC: If both p and q are given as equivalent recurring decimals award A0A1 eg $0.2\dot{1}6$ and $0.30\dot{3}$	



Question Number	Scheme	Marks
3 (a)	Width = **2.5 (cm)**	B1
	1.5 cm^2 for freq of 5 so $6\times1.5 = 9$ cm^2 for freq of 30 or fd $=\frac{5}{3}$ $w\times h = 9$	M1
	So $h = 9 \div 2.5$ or $6\div\frac{5}{3}$ = **3.6 (cm)**	A1
		(3)
(b)	$Q_2 = [12] + \frac{16}{25}\times 3$ allow use of $(n+1)$ giving $[12]+\frac{16.5}{25}\times 3$	M1
	$= 13.92 =$ awrt **13.9**	A1
		(2)
(c)(i)	$\sum fx = 5\times6.5 + 13\times9 + 16\times11 + 25\times13.5 + 30\times17.5 + 11\times24 = 1452$	M1
	$\bar{x} = 14.52 =$ awrt **14.5**	A1
		(2)
(ii)	$\sum fx^2 = 6.5^2\times5 + 9^2\times13 + 11^2\times16 + 13.5^2\times25 + 17.5^2\times30 + 24^2\times11 = 23\,280$	M1
	$\sigma_x = \sqrt{\frac{"23280"}{100} - ("14.52")^2}$ or $\sqrt{21.9696}$	M1
	$\sigma_x = 4.687\ldots =$ awrt **4.69**	A1
		(3)
(d)	$\frac{1}{2}\times13 + 16 + 25 + 30 + \frac{1}{4}\times11$	M1
	So proportion is 80.25 % or 0.8025 awrt **0.803**	A1
		(2)
(e)	Profit = $2.2\times"0.8025" + 0.8\times\frac{0.75\times11}{100} - 1.2\times"\left(1-\left[0.8025+\frac{0.75\times11}{100}\right]\right)"$	M1
	$= 1.6935$ awrt **1.7 (p)**	A1 (2)
	Notes	**[14 marks]**

(a)
B1 for width = 2.5 (cm)
M1 for sight of 9 cm^2 or $w\times h = 9$ or fd $=\frac{5}{3}$ (o.e.)
A1 for height = 3.6 (cm)

(b)
M1 for $\frac{16}{25}\times3$ or $\frac{9}{25}\times3$ or $\frac{m-12}{15-m}=\frac{16}{9}$
For any correct equation leading to Q_2 or correct fraction as part of Q_2
A1 for awrt 13.9 (use of $(n+1)$ giving 13.98 = awrt 14.0)

(c)(i)
M1 for attempt at Σfx with at least 3 correct terms or $900 < \Sigma fx < 1800$
for info $\Sigma fx = 32.5 + 117 + 176 + 337.5 + 525 + 264$
A1 for awrt 14.5 (correct answer only 2/2)

(ii)
1st M1 for attempt at Σfx^2 with at least 3 correct terms or $20\,000 < \Sigma fx^2 < 26\,000$
for info $\Sigma fx^2 = 211.25 + 1053 + 1936 + 4556.25 + 9187.5 + 6336$
2nd M1 for a correct expression including $\sqrt{}$ (ft their Σfx^2 if clear it is Σfx^2) Do not allow $(\Sigma fx)^2$ for Σfx^2
A1 for awrt 4.69 (allow s = 4.7107… awrt 4.71) (correct answer only 3/3)

(d)
M1 for attempt at a correct expression (allow 1 error or omission) eg $100-\left(5+\frac{13}{2}\right)-\frac{33}{4}$
A1 for awrt 80.3% or 0.803

(e)
M1 for a correct expression ft their 0.8025 o.e. eg
$\left[2.2\times(100-11.5-8.25)+0.8\times8.25-1.2\times11.5\right]\div100$
Condone $\left[2.2\times"80"+0.8\times(8)-1.2\times(12)\right]\div100$
A1 for awrt 1.7 Allow £0.017 (this must have units)

Question Number	Scheme	Marks
4. (a)	$P(W < 120) = P\left(Z < \frac{120-165}{35}\right)$	M1
	$= P(Z < -1.2857\ldots) = 1 - 0.9015$ <u>or</u> $1 - 0.9007285\ldots$	M1
	$= 0.09927\ldots$ = awrt **<u>0.0985~0.0994</u>**	A1
		(3)
(b)	e.g. $P(W > x) = \frac{1}{3}$ gives $\frac{x-165}{35} = \pm 0.43$ (calculator 0.430727…)	M1B1
	Limits 149.9245… to 180.0754… awrt **<u>150</u>** to **<u>180</u>**	A1, A1
		(4)
(c)	$P(W < 200 \mid W >$ "180") <u>or</u> $\frac{P("180" < W < 200)}{P(W > "180")}$ or $\frac{1}{3}$	M1
	$= \frac{0.8413(44739...) - \frac{2}{3}}{\frac{1}{3}}$	A1 (num)
	$= 0.52403\ldots$ **<u>(0.523~0.5264)</u>**	A1
		(3)
(d)	$\frac{1}{3} \times \frac{1}{3} \times \frac{1}{3}; \times 3!$	M1;M1
	$= \underline{\frac{2}{9}}$	A1
		(3)
		[13 marks]

	Notes
(a)	1st M1 for standardising with 120 (allow 210), 165 and 35. Accept $\pm$
	2nd M1 for attempting $1 - p$ [where $0.85 < p < 0.95$]
	A1 for awrt 0.0985~0.0994 (Correct ans only 3/3)
(b)	M1 for standardising with x (o.e.) 165 and 35 and setting equal to a z value, $0.4 < \lvert z \rvert < 0.5$ (Accept $\frac{165-x}{35} = \pm z$ where $0.4 < \lvert z \rvert < 0.5$)
	B1 for use of $z = 0.43$ or better We must see 0.43 or better.
	1st A1 for lower limit of awrt 150
	2nd A1 for upper limit of awrt 180
SC	A0A1 for two limits symmetrically placed about 165 provided M1 scored **NB**: correct answers with no working can score M1B0A1A1
(c)	M1 for a correct probability statement (either form) ft their 180 or a correct ratio
	1st A1 for a correct numerator (awrt 0.175)
	2nd A1 for an answer in the range awrt 0.523~0.5264 (use of 180 gives 0.5263869…)
(d)	1st M1 for $\left(\frac{1}{3}\right)^3$ (or equivalent)
	2nd M1 for $p \times 3!$ (or equivalent) where $0 < p < \frac{1}{6}$
	A1 for $\frac{2}{9}$ or any exact equivalent

Question Number	Scheme	Marks
5. (a)	{E(X) = } $-2a - b + 0\times c + b + 4a$ or $2a$	M1
	{ $2a = 0.5$ so } **$a = 0.25$**	A1
		(2)
(b)	{ E(X^2) =} $(-2)^2 \times a + (-1)^2 \times b + 0 + 1^2 \times b + 4^2 \times a$ or $20a + 2b$ (o.e.)	M1
	{Var(X) =}"$20a + 2b$" $- 0.5^2$	M1
	$20a + 2b - 0.25 = 5.01$ (o.e.) e.g. "4.75" $+ 2b = 5.01$	A1
	{ $2b = 0.26$ so } **$b = 0.13$**	A1
	{Use of sum of probs = 1 to calculate a 2nd value} **$c = 0.24$**	A1ft
		(5)
(c)(i)	{E(Y) $= 5 - 8\times 0.5$ } = **1**	B1
(ii)	{Var(Y) =} $(-8)^2 \times 5.01$	M1
	= 320.64 awrt **321**	A1
		(3)
(d)	$4X^2 > 5 - 8X$	M1
	$(2X-1)(2X+5) > 0 \Rightarrow X > 0.5$	M1A1
	So need $X = 1$ or 4 or probability of $a + b$	M1
	= **0.38**	A1
		(5)
		[15 marks]

	Notes	
(a)	M1	for any correct expression for E(X) in terms of a (or a, b, c)
	A1	for $a = 0.25$
(b)	1st M1	for attempt at an expression for E(X^2) with at least 3 correct non-zero terms
	2nd M1	for a correct expression for Var(X) eg"$18a - c + 1$" $- 0.5^2$ Allow with their value of a substituted
	1st A1	for a correct equation for b (or possibly c) eg"$18a - c + 1$" $- 0.5^2 = 5.01$ Allow with their value of a substituted
	2nd A1	for either $b = 0.13$ or $c = 0.24$
	3rd A1ft	for using $c = 1 - 2\times$"0.25" $- 2\times$"0.13" or $b = (1 - 2\times$"0.25" $-$"0.24" $)\div 2$ to gain the correct ft answer for their 2nd value
(c)	B1	for {E(Y) =} 1
	M1	for correct use of Var($aX + b$) = a^2 Var (X)
	A1	for awrt 321
(d)	1st M1	for correct quadratic inequality (may be inside prob statement) or table of values
	2nd M1	for an attempt to solve or identifying correct X values
	1st A1	for $X > 0.5$ [may also have $X < -2.5$]
	3rd M1	for realising need $X = 1$ and 4 only or answer of their ($a + b$)
	2nd A1	for 0.38 (or exact equivalent) only (correct ans only 5/5)

Question Number	Scheme	Marks
6. (a)	$\{S_{yy} =\} 42.63 - \dfrac{23.7^2}{16} \quad = [7.524375]$	B1
		(1)
(b)	Use of $\bar{y} = 3.684 - 0.3242\bar{x}$; so $\sum x = 16 \times \left(\dfrac{3.684 - \frac{23.7}{16}}{0.3242} \right) = 108.71067..$	M1; A1
	$\{S_{xx} =\} 756.81 - \dfrac{("108.71..")^2}{16}$; = 18.18435… awrt **18.2**	M1; A1
		(4)
(c)	$b = \dfrac{S_{xy}}{S_{xx}} \Rightarrow S_{xy} = "18.1843.." \times (-0.3242) [= -5.8953..]$; $r = \dfrac{"-5.89536..."}{\sqrt{"18.184.." \times 7.524375}}$	M1; M1
	$= -0.50399\ldots$ = **$-0.49 \sim -0.51$**	A1
		(3)
(d)	Sub $x = 2$ in the regression line gives $y = 3.0356$	B1
		(1)
(e)	St.dev = $\sqrt{\dfrac{S_{xx}}{n}} = \sqrt{\dfrac{"18.184..."}{16}} = 1.066...$	M1
	So limits are: $\dfrac{"108.71..."}{16} \pm 3 \times "1.066\ldots" =$ 3.5965…~ 9.9929… = awrt **3.6~10**	M1, A1
		(3)
(f)	The probability of $x = 2$ being in the range is very small; so Behrouz's estimate is unreliable	B1ft; dB1ft
		(2)
(g)	Should use regression of x on y to estimate unemployment or equivalent So Andi's suggestion is not suitable or not to be recommended	B1 dB1
		(2)
		[16 marks]

	Notes	
(a)	B1	Value given so must see sight of a correct expression – allow 561.69 for 23.7^2
(b)	1st M1	for clear use of regression line with $\bar{y}$ or $\sum y$
	1st A1	for $\sum x$ = awrt 109
	2nd M1	for a correct expression for S_{xx} ft their Σx
	2nd A1	for awrt 18.2
(c)	1st M1	for use of gradient to find S_{xy}
	2nd M1	for a correct expression for r ft their S_{xy} and S_{xx}
	A1	for an answer in the range –0.49 ~ –0.51
(d)	B1	for sight of $y = 3.03\ldots$ or better. Allow 3.04
(e)	1st M1	for a correct attempt at st. dev. ft their S_{xx} or $\sqrt{\dfrac{756.81}{16} - \left(\dfrac{"108.71..."}{16} \right)^2}$ ft their Σx
	2nd M1	for one correct calc…ft their values
	A1	for a range awrt 3.6~10
(f)	1st B1ft	for a correct reason ft their range in part (e) eg $x = 2$ is outside the range. Allow extrapolation
	2nd dB1ft	dep on 1st B1 for stating a correct conclusion for their range
(g)	1st B1	for a suitable reason based on reg line, eg regression line (y on x) can only be used to estimate wages. Allow x instead of unemployment and y instead of wages
	2nd dB1	dep on 1st B1 for suggesting not suitable (or equivalent)

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