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Mark Scheme (Results)

Summer 2012

GCE Statistics S1
(6683) Paper 1

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6683 Statistics S1
Mark Scheme

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 GCE 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 √ 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.

General Principles for Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),\ \text{where} \left|pq\right| = \left|c\right|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q),\ \text{where} \left|pq\right| = \left|c\right| \text{ and } \left|mn\right| = \left|a\right|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for *a*, *b* and *c*), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c,\ \ q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

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Mark Scheme

Question	Scheme	Marks
1. **(a)**	$\begin{array}{\|c\|c\|c\|c\|c\|}\hline x & -1 & 0 & 1 & 2 \\ \hline \mathrm{P}(X=x) & 4k & k & 0 & k \\ \hline \end{array}$	M1
	$4k + k + (0) + k = 1$ (Allow verify approach)	A1
	$6k = 1 \quad \Rightarrow \quad k = \frac{1}{6}$ (*)	A1cso (3)
(b)	$[\mathrm{E}(X)] = -4k\ (+0+0) + 2k$ or $-2k$ or $-1\times\frac{4}{6}+2\times\frac{1}{6}$	M1
	$= -\frac{1}{3}$ (or -0.3&)	A1 (2)
(c)	$\left[\mathrm{E}\left(X^2\right)\right] = (-1)^2\times 4k + (0+0) + 2^2 k$ or $4k+4k$ or $(-1)^2\times\frac{4}{6}+2^2\times\frac{1}{6}$ (o.e.)	M1
	$= \frac{4}{3}$ (*)	A1cso (2)
(d)	$[\mathrm{Var}(X)] = \frac{4}{3} - \left(-\frac{1}{3}\right)^2$ or $8k - 4k^2 = \left[\frac{11}{9}\right]$	$Y = 1-3X$: 4 1 −2 −5; Prob: $4k$ k 0 k; And $\mathrm{E}(Y) = 12k$
	$\mathrm{Var}(1-3X) = (-3)^2\,\mathrm{Var}(X)$ or $9\mathrm{Var}(X)$	$\mathrm{E}(Y^2) = 90k$ and $\mathrm{Var}(Y) = 90k - 144k^2$ M1
	$= 11$	A1 cao (3)
		[10]

Notes

(a)

M1 for attempt at $\mathrm{P}(X = x)$ with at least 2 correct. Do not give for 4, 1, etc but $\frac{4}{6}, \frac{1}{6}$ are OK

1st A1 for at least $4k + k + k = 1$ seen. Allow $\frac{4}{6}+\frac{1}{6}+\frac{1}{6}=1$ [Must see = 1]

2nd A1cso provided previous 2 marks are scored and no incorrect working seen

It's not essential to see $\mathrm{P}(X = -1) = 4k$ etc but if wrongly assigned probabilities such as $\mathrm{P}(X = 2) = 4k$ and $\mathrm{P}(X = -1) = k$ are seen then the final A1 is lost.

Verify To score final A1cso there must be a comment such as "therefore $k = \frac{1}{6}$"

Division by 4 (or any other *n*) in (b), (c) or (d) is M0. Do not apply ISW

(b)

M1 for a full correct expression for $\mathrm{E}(X)$, ft their probabilities. Allow in terms of k.

A1 for $-\frac{1}{3}$ or exact equivalent only. Just $-\frac{1}{3}$ scores M1A1

(c)

M1 for evidence of both non-zero terms seen. May be simplified but 2 terms needed.

A1cso for M1 seen leading to $\frac{4}{3}$ or any exact equivalent. Condone $-1^2\times 4k$ but not $-4k$

(d)

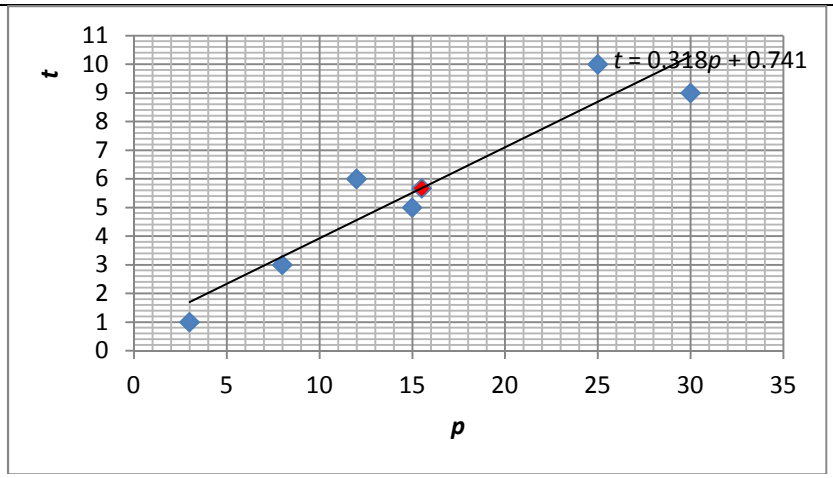
1st M1 for correct attempt at $\mathrm{Var}(X)$ - follow through their $\mathrm{E}(X)$ and allow in terms of k
Award if a correct formula is seen and some correct substitution made.

2nd M1 for correct use of $\mathrm{Var}(aX+b)$. Condone $-3^2\,\mathrm{Var}(X)$ if it eventually yields $9\mathrm{Var}(X)$

A1cao for 11 only

Question	Scheme	Marks
2. **(a)**	$\left[S_{xy} =\right]\ 23070 - \frac{477\times480}{12}\quad [=3990]$	B1
	$r = \frac{"3990"}{\sqrt{5606.25\times4244}}$	M1
	$= 0.81799\ldots$ **awrt 0.818**	A1 (3)
(b)	**0.818**	B1ft (1)
(c)	Positive correlation <u>or</u> value of r is close to 1 <u>or</u> value of r >0 (NOT "high/ strong correlation")	B1
	So there <u>is support</u> for the bank's claim <u>or</u> "increase in unemployment is accompanied by increase in house repossessions"	B1 (2)
		[6]

	Notes
(a)	**Marks for part (a) must be seen in (a), do not award if only seen in (b)**
	B1 for a correct expression for S_{xy}
	M1 for correct attempt at r f.t. their 3990 but $\frac{23070}{\sqrt{5606.25\times4244}}$ is M0
	A1 for awrt 0.818 If an answer of 0.82 only is seen then B1M1A0 can be given
(b)	B1ft for awrt 0.818 or f.t. their answer to part (a) for $\lvert r\rvert < 1$. Allow 2sf or 1sf follow through Answer in (b) must be correct or match one of their answers in (a). Must be a number.
(c)	1st B1 for a reason of positive correlation (allow even if $r > 1$) "positive skew" or "positive gradient" is B0 but 2nd B1 is still possible
	2nd B1 for a comment that suggest this supports the claim. Marks in (c) are independent but first B1 requires some idea of <u>positive</u> correlation
(c) SC	If $\lvert r\rvert < 0.2$ allow this alternative to the mark scheme:
	1st B1 for saying there is no or little correlation
	2nd B1 for a comment that says this does <u>not</u> support the bank's claim

Question	Scheme	Marks
3. **(a)**		Use overlay B1 B1 (2)
(b)	Points (appear to) lie close to a (straight) line <u>or</u> "strong /high correlation"	B1 (1)
(c)	$\sum p = 93$ and $\sum t = 34$ (may be seen in table) $S_{pt} = 694 - \frac{"93" \times "34"}{6} = [167]$ <u>or</u> $S_{pp} = 1967 - \frac{"93"^2}{6} = [525.5]$ $S_{pt} = 167$; S_{pp} = awrt 526	M1 M1 A1; A1 (4)
(d)	$b = \left[\frac{S_{pt}}{S_{pp}} =\right] \frac{"167"}{"525.5"} = [0.31779...]$ (**check their answer if expression not seen**) $a = \frac{"34"}{6} - "0.31779..." \times \frac{"93"}{6} = 5.666... - 0.31779... \times 15.5 =$, 0.74088… awrt 0.74 t **= 0.741 + 0.318**p (Accept $a = \frac{2336}{3153}$ and $b = \frac{334}{1051}$ in their equation)	B1ft M1, A1 A1 (4)
(e)	$(\bar{p}, \bar{t}) = (15.5, 5.7)$ plotted on the graph (not wholly outside the circle) Correct line plotted as per overlay. For $p = 5$; $2 < t < 3$ <u>and</u> for $p = 30$; $10 < t < 11$ Their line must stretch roughly as far as the points and go through the $(\bar{p}, \bar{t})$ circle	B1 B1 (2)
(f)	$t = "0.741" + "0.318" \times 16$ $= 5.825...$ **awrt 5.8**	M1 A1 (2) **[15]**

	Notes
(a)	B2 for all 6 data points plotted correctly. B1 for any 5 correct. Points not wholly outside the circles.
(c)	1st M1 for attempting $\sum p$ and $\sum t$. Allow $80 < \sum p < 100$ and $30 < \sum t < 40$ 2nd M1 for one correct expression for S_{pt} or S_{pp}, f.t. their $\sum p$ and $\sum t$. 1st A1 for S_{pt} 2nd for S_{pp}
(d)	B1ft for correct expression for the gradient, f.t. their 167 and 525.5 from (c) M1 for correct use of $a = \bar{t} - b\bar{p}$ f.t. their values. Condone 5.6 for $\bar{t}$ 1st A1 for awrt 0.74 NB use of 526 gives 0.745566… and gets A0 2nd A1 for a correct equation for t in terms of p with a and b awrt 3sf An equn in y or x is A0
(f)	M1 for clear use of their line (equation or on graph) and $p = 16$ to estimate t. This may be an expression or lines marked on the diagram A1 for awrt 5.8, even if their line is not fully correct. Accept "$t > 5.8$"(oe). Answer only 2/2

Question		Scheme	Marks
4.	**(a)**	B, W or T, W [accept $B \cup T, W$ or $B \cap T, W$] [Condone P(B), P(W) etc]	B1
		Since there is no overlap between the events or cannot happen together (o.e.) (Accept comment in context e.g. "no one walks and takes the train")	B1 (2)
	(b)	e.g. $P(B) = \frac{9}{25}$, $P(T) = \frac{8}{25}$, $P(B \cap T) = \frac{5}{25}$	M1
		$P(B \cap T) \neq P(B) \times P(T)$ [$0.2 \neq 0.36 \times 0.32 = 0.1152$ o.e.]	M1
		So B and T are not independent	A1cso (3)
	(c)	[$P(W) =$] $\frac{7}{25}$ or 0.28	B1 (1)
	(d)	[$P(B \cap T) =$] $\frac{5}{25}$ or $\frac{1}{5}$ or 0.2	B1 (1)
	(e)	[$P(T \mid B) =$] $\frac{P(T \cap B)}{P(B)} = \frac{\text{"(d)"}}{(5+4)/25}$	M1
		$= \frac{5}{9}$ or 0.5 &	A1 (2)
			[9]

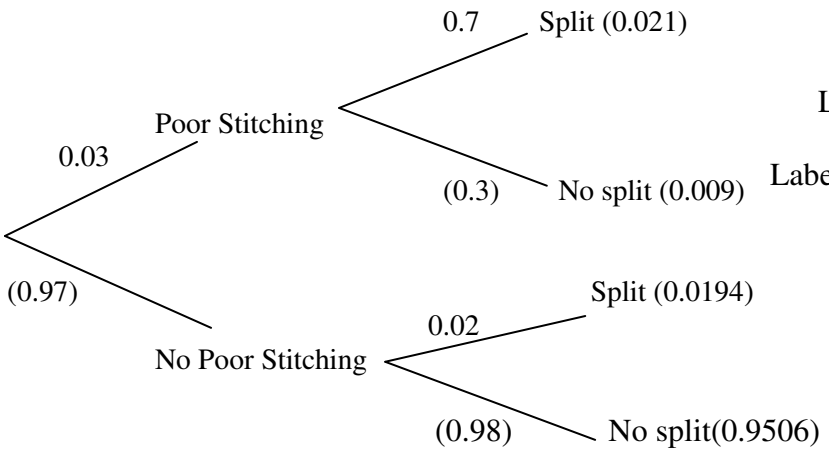
	Notes
(a)	1st B1 for a suitable pair. Do not accept universally exclusive pairs such as B and B' etc 2nd B1 for any correct statement. Accept use of symbols e.g.: $B \cap W = \varnothing$ or $P(T \cap W) = 0$ etc But $T \cap W = 0$ is B0 (since it is not a correct statement)
(b)	1st M1 for an attempt at all required probabilities with labels for a suitable test (allow one error). Accept use of A and B as long as they can be identified as B and T by correct probabilities Must be probabilities not integers such as 5, 9, 8 etc for both these M marks 2nd M1 for $P(B) \times P(T)$ evaluated (correct for their probabilities) or $P(B \cap T) \neq P(B) \times P(T)$ stated or implied in symbols or using their probabilities. or $P(B \mid T) \neq P(B)$ or $P(T \mid B) \neq P(T)$ stated or implied in symbols or using their probabilities. A1 for a conclusion of not independent. Requires all probabilities used to be correct and seen. This A mark is dependent on both Ms NB $P(B \mid T) = \frac{5}{8}$ & $P(B) = \frac{9}{25}$ or $P(T \mid B) = \frac{5}{9}$ & $P(T) = \frac{8}{25}$ seen, followed by a correct conclusion scores 3/3
(e)	M1 for a correct ratio of probabilities e.g. $\frac{5/25}{(5+4)/25}$ or $\frac{5}{5+4}$ or A correct ratio expression and at least one correct (or correct f.t.) probability substituted. A1 for $\frac{5}{9}$ with no incorrect working seen but $\frac{5}{9}$ following from $P(B \mid T)$ is 0/2. $\frac{5}{9}$ alone is 2/2

Question	Scheme	Marks
5. **(a)**	One large square = $\frac{450}{"22.5"}$ or one small square = $\frac{450}{"562.5"}$ (o.e. e.g. $\frac{"562.5"}{450}$)	M1
	One large square = 20 cars or one small square = 0.8 cars or 1 car = 1.25 squares	A1
	No. > 35 mph is: $4.5\times"20"$ or $112.5\times"0.8"$ (or equivalent e.g. using fd)	dM1
	= **90** (cars)	A1 (4)
(b)	$[\bar{x}] = \frac{30\times12.5+240\times25+90\times32.5+30\times37.5+60\times42.5}{450}$ $\left[=\frac{12975}{450}\right]$	M1 M1
	= 28.83... or $\frac{173}{6}$ **awrt 28.8**	A1 (3)
(c)	$[Q_2 =]$ $20+\frac{195}{240}\times10$ (o.e.) [Allow use of $(n+1)$ giving 195.5 instead of 195]	M1
	= 28.125 [Use of $(n+1)$ gives 28.145…] **awrt 28.1**	A1 (2)
(d)	$Q_2 < \bar{x}$ So positive skew | [Condone $Q_2 \approx \bar{x}$] [so (almost) symmetric]	B1ft dB1ft (2)
(e)	[If chose skew in (d)] **median (Q_2)** Since the data is skewed or median not affected by extreme values | [If chose symmetric in (d)] **mean ($\bar{x}$)** Since it uses all the data	B1 dB1 (2)
		[13]

	Notes
(a)	1st M1 for attempt to count squares (accept "22.5" in [22, 23] and "562.5" in [550, 575]) **and** use 450 to obtain a measure of scale. [If using fd must use 450 to obtain scale factor]
	1st A1 for a correct calc. for 20 or 0.8 or 1.25 etc
	[May be fd = 4 to 1 large sq. or 0.8 to 1 small sq. May be on the diagram.]
	2nd dM1 dep on 1st M1 for correctly counting squares for > 35 mph and forming suitable expr'
	2nd A1 for 90 with no incorrect working seen.
	e.g. $\frac{4.5}{22.5}\times450$ scores M1A1M1 and A1 when = 90 is seen. Answer only is 4/4
(b)	1st M1 for clear, sensible use of mid-points at least 3 of (12.5, 25, 32.5, 37.5, 42.5) seen
	2nd M1 for an expression for $\bar{x}$ (at least 3 correct terms on num' and a compatible denominator)
	Follow through their frequencies.
	You may see these fractions: $\frac{16218.75}{562.5}$ (small squares), $\frac{12975}{450}$ (frequencies), $\frac{648.75}{22.5}$ (large squares)
	A1 for awrt 28.8 (answer only is 3/3)
(c)	M1 for a full expression for median (using their frequencies). May see e.g. $25+\frac{75}{120}\times5$ etc
	Do nor accept boundaries of 19.5 or 20.5, these are M0A0
	A1 for awrt 28.1 (answer only is 2/2) [For use of $(n+1)$ accept 28.15 but not 28.2]
(d)	1st B1ft for a correct statement about their Q_2 and $\bar{x}$ [Condone $Q_2 \approx \bar{x}$ only if $\lvert Q_2 - \bar{x}\rvert < 1$]
	Do not accept an argument based on the shape of the graph alone.
	2nd dB1ft dependent on 1st B1 for a compatible description of skewness. F.t. their values
Quartiles	If $Q_1 = 23.4$ and $Q_3 = 33.7 \sim 33.8$ are seen allow comparison of quartiles for 1st B1 in (d)
(e)	1st B1 for a correct choice based on their skewness comment in (d). If no choice made in (d) only Q_2
	2nd dB1 for a suitable compatible comment

Question	Scheme	Marks
6. (a)	$[z =] \pm\left(\frac{150-162}{7.5}\right)$	M1
	$[z =] -1.6$	A1
	$[\mathrm{P}(F > 150) = \mathrm{P}(Z > -1.6) =] = 0.9452(0071\ldots)$ **awrt <u>0.945</u>**	A1 (3)
(b)	$z = \pm 0.2533$ (or better seen)	B1
	$(\pm)\frac{s-162}{7.5} = 0.2533(47\ldots)$	M1
	$s = 163.9$ **awrt <u>164</u>**	A1 (3)
(c)	$z = \pm 1.2816$ (or better seen)	B1
	$\frac{162-\mu}{9} = -1.2815515...$	M1 A1
	$\mu = 173.533\ldots$ **awrt <u>174</u>**	A1 (4)
		[10]

	Notes
(a)	M1 for attempting to standardise with 150, 162 and 7.5. Accept <u>±</u> Allow use of symmetry and therefore 174 instead of 150 1st A1 for -1.6 seen. Allow 1.6 seen if 174 used or awrt 0.945 is seen. Sight of 0.945(2) is A1. 2nd A1 for awrt 0.945 Do not apply ISW, if 0.9452 is followed by 1 – 0.9452 then award A0 Correct answer only 3/3
(b)	B1 for $(z =) \pm 0.2533$ (or better) seen. Giving $z = \pm 0.25$ or ± 0.253 scores B0 here but may get M1A1 M1 for standardising with s (o.e.), 162 and 7.5, allow <u>±</u>, and setting equal to a z value Only allow $0.24 \leq z \leq 0.26$ Condone e.g. 160 for 162 etc A1 for awrt 164 (Correct answer only scores B0M1A1)
(c)	B1 for $(z =) \pm 1.2816$ (or better) seen. Allow awrt <u>±</u> 1.28 if B0 scored in (b) for z = awrt<u>±</u> 0.25 M1 for attempting to standardise with 162, 9 and μ, and setting equal to a z value where $1.26 < \lvert z\rvert < 1.31$. Allow <u>±</u> here so signs don't have to be compatible. 1st A1 for a correct equation <u>with</u> compatible signs and $1.26 < \lvert z\rvert < 1.31$ 2nd A1 for awrt 174 (Correct answer only scores B0M1A1A1). **Dependent on 1st A1**
NB	An equation $\frac{162-\mu}{9} = 1.2816$ leading to an answer of $\mu = 174$ is A0A0 <u>unless</u> there is clear correct working such as: $\frac{162-x}{9} = 1.2816 \Rightarrow x = \ldots \therefore \mu = 162 + (162 - x) = 174$ then award A1A1 A common error is: $\frac{162-\mu}{9} = 1.2816$ followed by $\mu = 162 + 9 \times 1.2816$ = awrt 174 It gets A0A0

Question	Scheme	Marks
7. (a)	 Shape Labels & 0.03 Labels & 0.7,0.02	B1 B1 B1 (3)
(b)	P(Exactly one defect) = $0.03\times0.3+0.97\times0.02$ or $P(PS\cup Split)-2P(PS\cap Split)$ = [0.009 + 0.0194 =] **0.0284**	M1A1ft A1 cao (3)
(c)	P(No defects) = $(1-0.03)\times(1-0.02)\times(1-0.05)$ (or better) = 0.90307 **awrt 0.903**	M1 A1 cao (2)
(d)	P(Exactly one defect) = (b)$\times(1-0.05)$ + $(1-0.03)\times(1-0.02)\times0.05$ = "0.0284"$\times0.95+0.97\times0.98\times0.05$ = [0.02698 + 0.04753] = 0.07451 **awrt 0.0745**	M1 M1 A1ft A1 cao (4) **[12]**

	Notes
	Allow MR of 0.2 for 0.02 or 0.3 for 0.03 on tree diagram to score all M and A1ft marks only
(a)	1st B1 for 2 branch then 4 branch shape 2nd dB1 dep. on 1st B1 for labels showing stitching (accept letters) and 0.03 value correctly placed 3rd dB1 dep. on 1st B1 for labels showing splitting and 0.7 and 0.02 correctly placed [probabilities shown in brackets are not required and any such values given can be ignored in (a)]
(b)	M1 for $0.03\times p+0.02\times q$ where p and q follow from their tree diagram. Extra terms is M0 1st A1ft for a fully correct expression. Accept $1-0.7$ for 0.3 and $1-0.03$ for 0.97 Follow through 0.2 and 0.3 MR only
MR	0.2 for 0.02 $\rightarrow$0.203 or 0.3 for 0.03 $\rightarrow$ 0.104 or both $\rightarrow$ 0.23 should score M1A1A0 2nd A1 cao for 0.0284 only (or exact equivalent such as $\frac{71}{2500}$)
	Do not allow 0.5 as MR of 0.05 so no M or A marks in (c) or (d)
(c)	M1 for (their 0.97)$\times$(their 0.98)$\times(1-0.05)$ (or better) f.t. values from their tree diagram A1 cao for awrt 0.903
(d)	1st M1 for one correct triple (or correct ft from their tree) of: $[0.03\times0.3\times(1-0.05)]+[0.97\times0.02\times(1-0.05)]+[0.97\times0.98\times0.05]$ 2nd M1 for two correct triples or correct ft from their tree and adding or their (b) $\times(1-0.05)$ 1st A1ft for a fully correct expression or f.t. their (b) and 0.2 or 0.3 MR only
MR	0.2 for 0.02 $\rightarrow$0.23165 or 0.3 for 0.03 $\rightarrow$0.1331 or both $\rightarrow$0.2465 (or awrt 3sf) scores M1M1A1A0 2nd A1 cao for awrt 0.0745

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