Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE in Statistics S1 (6683/01)

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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.

PEARSON 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.

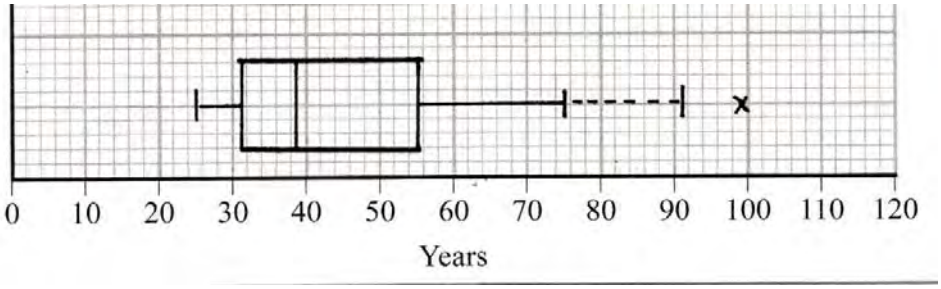
   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\surd$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which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

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 all the attempts and score the highest single attempt.

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

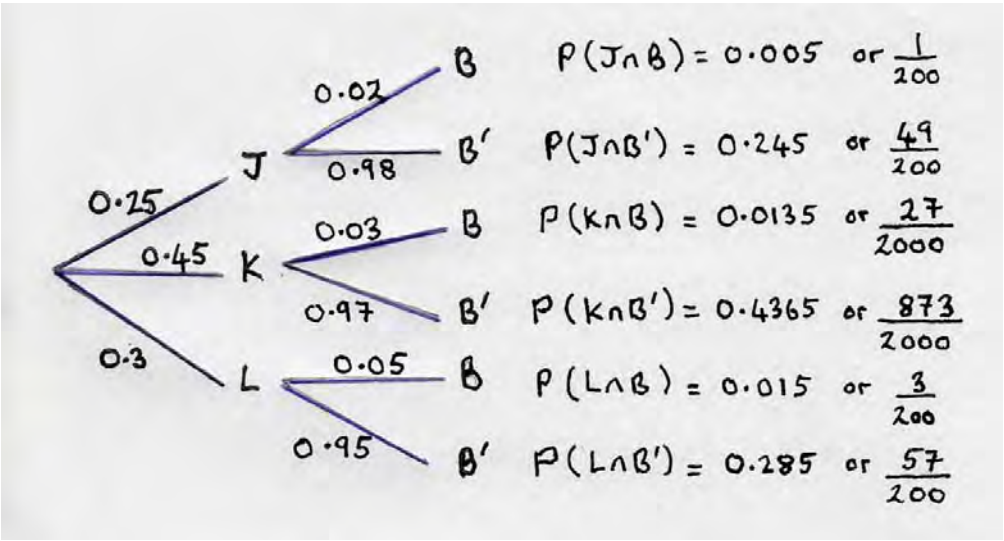
Question Number	Scheme		Marks
1. (a)	$a = 44$ $b = 76$	These answers may be in or near the table	B1 B1 **(2)**
(b)	$55+1.5(55-31)=91$ [and $31-1.5(55-31)=-5$] **Penville**  		M1 B1 B1 A1 **(4)**
(c)	Greenslax : $[Q_2-Q_1=20,\ Q_3-Q_2=12$ or $(Q_2-Q_1)>(Q_3-Q_2)]\Rightarrow$ –ve(skew) Penville: $[Q_2-Q_1=8,\ Q_3-Q_2=16$ or $(Q_3-Q_2)>(Q_2-Q_1)]\Rightarrow$ +ve (skew) Don't insist on seeing "skew" so just –ve and +ve will do. Treat "correlation" as ISW Justification that is consistent		B1 B1 ddB1 **(3)** **Total 9**

	Notes
(b)	**A fully correct box plot scores 4/4. If <u>not</u> fully correct apply scheme and need evidence for M1** **If two box plots are seen ignore the one for Greenslax. If not on graph paper M1 max for (b)** M1 for sight of $55+1.5(55-31)$ <u>or</u> 91 seen (possibly implied by RH whisker of box plot) May be implied by a fully correct box plot 1st B1 box with whiskers (condone missing median) 2nd B1 25, 31, 39, 55, RH whisker to end at 75 or 91. Two RH whiskers is B0 Accuracy must be to within 0.5 of a square so e.g. lower quartile at 30 or 32 is OK
(c)	A1 only one outlier plotted at 99. Allow cross to be vertically displaced If the RH whisker goes to 99 (2nd B0) <u>and</u> A0 even if outlier is identified since we require a horizontal "gap" between RH whisker and outlier. 1st B1 Greenslax – ve (skew) 2nd B1 Penville + ve (skew). We must be able to tell which is which but labels may be implied by their <u>values</u> but not simply from $Q_3-Q_2>Q_2-Q_1$ If there is just <u>one</u>, unlabelled comment assume Penville. 3rd ddB1 dependent on 1st and 2nd B marks being scored. Justification for <u>both</u> based on: quartiles, median relative to quartiles, or "tail" If only values for Q_3-Q_2 etc are <u>given</u> they should be correct ft for Greenslax and correct for Penville If values for Greenslax imply +ve skew then 1st B0 and 3rd B0

Question Number	Scheme	Marks
2	mean $= \frac{60.8+20}{1.4}$ <u>or</u> $60.8 = 1.4x - 20$ (o.e.)	M1
	$=$ 57.7142… awrt **57.7**	A1
	standard deviation $= \frac{6.60}{1.4}$ <u>or</u> $6.60 = 1.4x$	M1
	$=$ 4.7142… awrt **4.71**	A1
		(4)
		Total 4
	Notes	
	1st M1 sub. 60.8 for *y* into a correct equation. Allow use of *x* or any other letter or expression for mean 1st A1 for awrt 57.7 or $\frac{404}{7}$ (o.e.). Correct answer only is 2/2 2nd M1 sub. 6.60 or 6.6 for *y* and ignoring the 20 Allow use of *x* or any other letter or expression for st. dev. $6.60^2 = 1.4^2 x^2$ is M0 until we see them take a square root. 2nd A1 for awrt 4.71 or $\frac{33}{7}$ (o.e.). Correct answer only is 2/2	

Question Number		Scheme	Marks
3	(a)	$r = \dfrac{31512.5}{\sqrt{42587.5 \times 25187.5}} = 0.962$ awrt **0.962**	M1 A1 **(2)**
	(b)	r is close to 1 <u>or</u> a **strong correlation**. ["points are close to a straight line" isB0] [Just "positive" correlation is B0] [Use of "relationship" or "skew" not "correlation" is B0]	B1 **(1)**
	(c)	$b = \dfrac{31512.5}{42587.5} = 0.739947... = 0.740$ (3 dp) **0.740** (only)	M1 A1cao **(2)**
	(d)	$a = 1326.25 - (0.7399\ldots \times 2423.75)$ [= – 467.2 or awrt – 467] So $\boldsymbol{m = -467 + 0.74v}$	M1 A1 **(2)**
	(e)	b is the <u>money</u> <u>(spent)</u> per <u>visitor</u>. (i.e. definition of a rate in words.)[ignore values] So each 1000 visitors generates an extra £0.74 million <u>or</u> each visitor spends £740 oe	B1 B1ft **(2)**
	(f)	$m = -467 + 0.74 \times 2500$ m = 1383 (£ million) awrt **1380**	M1 A1 **(2)**
	(g)	As 2500 is within the range of the data set <u>or</u> it involves <u>interpolation</u>. The value of money spent is reliable	B1 dB1 **(2)**
			Total 13

	Notes
(a)	M1 for a correct expression for r. Ans only of 0.96 or awrt 0.96 is M1A0 Ans only of 0.962 or awrt 0.962 is M1A1. Do not allow fractions for A1
(b)	B1 for comment implying strong correlation. (e.g. big/high/clear etc) B0 if $\lvert r \rvert > 1$
(c)	M1 for a correct expression for b (may be implied by 0.74 or better in regression equation) A1 A1 for 0.740 only in (c) or b = 0.740 seen elsewhere (M1A0 for $\dfrac{2521}{3407}$ or awrt 0.74 here)
(d)	M1 for 1326.25 – ('their b' × 2423.75) Condone fractions or awrt 1330 for $\bar{m}$ and awrt 2420 for $\bar{v}$ A1 for a correct equation in m and v with a = awrt – 467 and b = awrt 0.74 Condone $\frac{2521}{3407}$ for b and $\frac{-1591740}{3407}$ for a. [Equation in y and x is A0]
(e)	1st B1 for a correct definition of the rate in words. Must state or imply "money per visitor" Allow alternative words or symbols e.g. £ or "pounds" for money, "people" for visitors etc 2nd B1ft for a correct numerical rate (ft their value of b) e.g. "each <u>visitor</u> <u>spends</u> £740" is B1B1, "b is the extra <u>money</u> spent per <u>visitor</u>" is B1B0 [no values] "b is increase of <u>£0.74 million</u> in m as v increases <u>by 1000</u>" is B0B1[£ for money but no "visitors"] "increase in <u>m</u> as <u>v</u> increases" is B0B0 [Idea of rate but letters not words and no numerical value of rate]
(f)	M1 sub. v = 2500 into <u>their</u> equation. Simply substituting 2 500 000 is M0 (unless adjusted eqn) A1 awrt 1380 units (£ and million not required)
(g)	1st B1 for 2500 <u>or</u> 2 500 000 <u>or</u> visitors <u>or</u> v is in range. "it" is B0 unless v clearly implied 2nd dB1 for stating it <u>is</u> reliable. Dependent on previous B mark being awarded "both v and m in range" <u>or</u> "1380 in range" is B0 but use ISW so "interpolation since both in range" scores B1 for the "interpolation". "Not extrapolation" counts as "interpolation"

Question Number	Scheme	Marks
4 (a)		M1 A1 **(2)**
(b)	0.25×0.98, = **0.245** (or exact equiv. e.g. $\frac{49}{200}$)	M1A1 **(2)**
(c)	$0.25\times0.02+0.45\times0.03+0.3\times0.05$, = **0.0335** (or exact equiv. e.g. $\frac{67}{2000}$)	M1A1 **(2)**
(d)	$[\mathrm{P}(J\cup L\mid B)] = \frac{0.25\times0.02+0.3\times0.05}{0.0335}$ or $\frac{0.0335-0.45\times0.03}{0.0335}$ $=0.5970...$ awrt **0.597** (or $\frac{40}{67}$ or exact equiv.)	M1A1ft A1 **(3)**
	Notes	**Total 9**
	Allow fractions or percentages throughout this question	
(a)	Allow 3+6 tree diagram with the 6 correct "end" probs and labels to get 2/2 (1st, 3rd, 5th gets M1) M1 for (3+6) tree drawn with 0.25, 0.45, 0.02, 0.03, 0.05 on correct branches A1 for 0.3, 0.98, 0.97, 0.95 on the correct branches and labels, condone missing B's **Correct answer only scores full marks for parts (b), (c) and (d)** **When using "their probability *p*" for M1 and A1ft they must have $0 < p < 1$**	
(b)	M1 for $0.25\times$ 'their 0.98' o.e.	
(c)	M1 for $0.25\times$their $0.02+0.45\times$their $0.03+$their $0.3\times$their 0.05 Condone 1 transcription error. Or $1-(0.25\times$their $0.98+0.45\times$their $0.97+$their $0.3\times$their $0.95)$	
(d)	M1 for use of conditional probability with their (c) as denominator. Also exactly 2 products on num' and at least one correct (or correct ft) or their (c) – one of the products from their (c). Ignore an incorrect expression inside their probability statement A1ft for $\frac{0.25\times\text{their }0.02+\text{their }0.3\times\text{their }0.05}{\text{their(c)}}$ or $\frac{\text{their (c)}-0.45\times\text{their }0.03}{\text{their (c)}}$ or $\frac{0.02}{\text{their (c)}}$ A1 awrt 0.597 or exact fraction e.g. $\frac{40}{67}$	

Question Number		Scheme	Marks
5	(a)	$2k + 4k + 6k + k(8 - 2) = 1$ (commas instead of + or a table OK if $18k = 1$ seen later)	M1
		$k = \frac{1}{18}$ **(*)**	A1cso **(2)**
	(b)	$[2k + 4k] = \frac{6}{18} = \frac{1}{3}$ ($\frac{1}{3}$ or any exact numerical equivalent)	B1 **(1)**
	(c)	$E(X) = \left(2 \times \frac{1}{9}\right) + \left(4 \times \frac{2}{9}\right) + \left(6 \times \frac{1}{3}\right) + \left(8 \times \frac{1}{3}\right)$ or $(2 \times 2k) + (4 \times 4k) + (6 \times 6k) + (8 \times 6k)$	M1
		$= 5\frac{7}{9}$ (or exact equivalent e.g. $\frac{52}{9}$)	A1 **(2)**
	(d)	$E(X^2) = \left(4 \times \frac{1}{9}\right) + \left(16 \times \frac{2}{9}\right) + \left(36 \times \frac{1}{3}\right) + \left(64 \times \frac{1}{3}\right)$ or $(4 \times 2k) + (16 \times 4k) + (36 \times 6k) + (64 \times 6k)$	M1
		$= 37\frac{1}{3}$ (or exact equivalent e.g. $\frac{112}{3}$)	A1 **(2)**
	(e)	$\text{Var}(X) = 37\frac{1}{3} - \left(5\frac{7}{9}\right)^2$ [= 3.95… or $\frac{320}{81}$]	M1
		$\text{Var}(3 - 4X) = 16 \times 3.95\ldots$	M1
		= awrt **63.2** (allow $\frac{5120}{81}$)	A1 **(3)**
			Total 10

	Notes
(a)	M1 for $2k + 4k + 6k + k(8 - 2) = 1$ A1 for $k = \frac{1}{18}$ NB cso so no incorrect working seen or M1 for $2 \times \frac{1}{18} + 4 \times \frac{1}{18} + 6 \times \frac{1}{18} + \frac{1}{18}(8 - 2)$ A1 for =1 and "therefore $k = \frac{1}{18}$"
	If in parts (c), (d) and (e) there is a correct expression worthy of M1 but later they incorrectly go on and multiply or divide by some number *n*, then allow the M1 but mark their final answer (A0) Answers only in (b), (c), (d) and (e) score all the marks.
(c)	M1 for an expression for $E(X)$ with at least 3 correct terms (products) allow use of k e.g. $104k$
(d)	M1 for an expression for $E(X^2)$ with at least 3 correct terms (products) allow use of k e.g. $672k$ A1 for any exact equivalent only. E.g. 37.3 is A0 but, of course, $37.\dot{3}$ is OK
(e)	1st M1 for $E(X^2) - [E(X)]^2$ ft their answers to (c) and (d). Must see values used correctly. 2nd M1 for statement "$4^2 \times \text{Var}(X)$"seen or for $4^2 \times$ their $\text{Var}(X)$ provided their $\text{Var}(X) > 0$ Do not allow for $16 \times E(X^2)$ but can score M0M1 NB condone $-4^2 \times \text{Var}(X)$ if the answer later becomes positive. A1 for exact fraction ($\frac{5120}{81}$ o.e.) or decimal approximation that is awrt 63.2 **Beware:** rounding to 3sf in (c) (5.78) and (d) (37.3) gives 62.3 which could be misread as 63.2

Question Number	Scheme	Marks
6 (a)	70 – 80 group - width **0.5 (**cm)	B1
	1.5 cm^2 is 10 customers <u>or</u> 3.75cm^2 is 25 customers <u>or</u> $0.5c = 3.75$ <u>or</u> $\frac{2.5}{\frac{1}{3}}$	M1
	70 – 80 group - height **7.5 (**cm)	A1
		(3)
(b)	Median = $(70) + \frac{13.5}{25} \times 10$ allow $(n + 1) = (70) + \frac{14}{25} \times 10$	M1
	= **75.4** (or if using $(n + 1)$ allow 75.6)	A1
		(2)
(c)	$\left[\text{Mean} = \frac{6460}{85}\right] =$ **76**	B1
	$\sigma = \sqrt{\frac{529400}{85} - 76^2}$	M1
	= 21.2658……. (s = 21.3920) **awrt 21.3**	A1
		(3)
(d)	Coeff' of skewness = $\frac{3(76 - 75.4)}{21.2658...}$ = 0.08464… **awrt 0.08** (awrt 0.06 for 75.6)	M1 A1
	There is (very slight) positive skew or the data is almost symmetrical (or both) <u>Any</u> mention of "correlation" is B0	B1ft
		(3)
		Total 11

	Notes
(a)	B1 for 0.5
	M1 for one of the given statements <u>or</u> any method where "their width" × "their height" = 3.75 Correct height scores M1A1 independent of width so B0M1A1 is possible.
(b)	M1 for a correct fraction: $+\frac{k}{25} \times 10$ where k = 13.5 or 14 for $(n + 1)$ case.
	NB may work down so look out for $(80) - \frac{11.5}{25} \times 10$ etc **Beware:** $69.5 + \frac{13.5}{25} \times 11 = 75.44$ (but M0)
(c)	M1 for a correct expression with square root, ft their mean A1 for awrt 21.3 or, if clearly using s allow awrt 21.4. Must be evaluated...no surds.
(d)	M1 sub. their values into formula allow use of s but their σ or s must be > 0 A1 for awrt 0.08 but accept 0.085 No fraction B1ft for a correct comment compatible with their coefficient. Allow "symmetrical" for |coeff'| < 0.25 They may say it is "slightly skew" so omit "positive" but do not allow "negative" if coef' +ve Condone "strongly" positive skew.

Question Number		Scheme	Marks
7	(a)	The random variable H ~ height of females	
		$\mathrm{P}(H>170) = \mathrm{P}\left(Z>\frac{170-160}{8}\right)$ $[=\mathrm{P}(Z>1.25)]$	M1
		$=1-0.8944$	M1
		= 0.1056 (calc 0.1056498…) **awrt 0.106** (accept 10.6%)	A1 **(3)**
	(b)	$\mathrm{P}(H>180) = \mathrm{P}\left(Z>\frac{180-160}{8}\right)$ $[=1-0.9938]$	M1
		= 0.0062 (calc 0.006209…) awrt 0.0062 or $\frac{31}{5000}$	A1
		$[\mathrm{P}(H>180 \mid H>170)] = \frac{0.0062}{0.1056}$	M1
		= 0.0587 (calc 0.0587760…) **awrt 0.0587 or 0.0588**	A1 **(4)**
	(c)	P($H > h \mid H >170$) (= 0.5) or $\frac{\mathrm{P}(H>h)}{\mathrm{P}(H>170)}(=0.5)$	M1
		[P($H > h$)] = $0.5\times$"0.1056" = 0.0528 (calc 0.0528249…) or [P($H < h$)] = 0.9472	A1ft
		$\frac{h-160}{8}=1.62$ (calc 1.6180592…)	M1 B1
		h = awrt 173 cm **awrt 173**	A1 **(5)**
			Total 12

	Notes
(a)	1st M1 for attempt at standardising with 170, 160 and 8. Allow ± i.e. for $\pm\frac{170-160}{8}$
	2nd M1 for attempting $1 - p$ where $0.8 < p < 1$. Correct answer only 3/3
(b)	1st M1 for standardising with 180, 160 and 8
	1st A1 for 0.0062 seen, maybe seen as part of another expression/calculation.
	2nd M1 using conditional probability with denom = their (a) and num < their denom. Values needed.
	2nd A1 for awrt 0.0587 or 0.0588. Condone 5.87% or 5.88% or $\frac{31}{528}$
	Correct answer only 4/4
(c)	1st M1 for a correct conditional probability statement. Either line and don't insist on 0.5, ft (a)
	1st A1ft for [P($H > h$)] = $0.5\times$ their(a)
	Award M1A1ft for correct evaluation of $0.5\times$ their(a) or sight of 0.0528 or better
	2nd M1 for attempt to standardise (±) with 160 and 8 and set equal to ± z value ($1.56 < \lvert z\rvert < 1.68$)
	B1 for (z =) awrt ± 1.62 (seen)
	2nd A1 for awrt 173 but dependent on both M marks.

Question Number	Scheme	Marks
8 (a)	$[\,P(A) = 1 - 0.18 - 0.22\,]$ = **0.6** (or exact equivalent)	B1 **(1)**
(b)	$P(A \cup B) = "0.6" + 0.22$ = **0.82** (or exact equivalent)	B1ft **(1)**
(c)	$x = P(A \cap B)$ | Use $P(B)P(A' \mid B) = P(A' \cap B)$ | **Establish** independence before or after 1st M1and score marks for (d) (RH ver)	M1
	$\frac{x}{x+0.22} = 0.6$ | $P(B) \times [1 - 0.6] = 0.22$ | **Find** $P(B)$	
	$x = 0.6x + 0.132$ | Use $P(A \cap B) = P(A \mid B)P(B)$ | Use $P(B)P(A) = P(A \cap B)$	dM1
	$0.4x = 0.132$ | $P(A \cap B) = 0.6 \times 0.55$ | $P(A \cap B) = 0.6 \times 0.55$	
	x = **0.33** (or exact equivalent)	A1cso **(3)**
(d)	$P(B) = 0.55$	
	$P(B) \times P(A) = 0.55 \times 0.6$ = 0.33 | **or** stating $P(A) = P(A\|B)$ [= 0.6]	M1
	$P(B) \times P(A) = P(A \cap B)$ therefore (statistically) independent | **or** $P(A) = P(A\|B)$ therefore (statistically) independent	A1cso **(2)**
		Total 7

	Notes
(b)	B1ft for their (a) + 0.22 or 1 − $P(A' \cap B')$ Do not ft their (a) if it is > 0.78
	NB 3 versions for (c). Check carefully that Ms are genuinely scored.
	Look out for <u>assuming independence</u> and if you see P(*B*) = 0.55 check it is <u>derived</u> properly
(c)	1st M1 for a correct equation for x e.g. $\frac{x}{x+0.22} = 0.6$ <u>or</u> a correctly derived equation for $P(B)$
	2nd dM1 for solving to get in form $kx = L$ <u>or</u> <u>correct</u> use of $P(B)$ to find $P(A \cap B)$ [2nd or 3rd ver] <u>or</u> $P(A \cap B) = P(B) - 0.22$
	A1cso for 0.33 Dep. on <u>both</u> Ms and no incorrect working seen.
(d)	M1 for finding $P(B) \times P(A) = 0.33$ (values needed) <u>or</u> stating $P(A) = P(A\|B)$ (= 0.6 not needed)
	A1cso for a correct statement: $P(B) \times P(A) = P(A \cap B)$ or $P(A) = P(A\|B)$ <u>and</u> stating independent
	NB The M1 in (d) using $P(A \cap B)$ requires $P(B) = 0.55$ There is no ft of an incorrect $P(B)$ Full marks in (d) is OK even if 0/3 in (c)
	{This Venn diagram may be helpful.}