Question Number	Scheme	Marks
1.(a)	[F(5) =] $\frac{5}{6}$	B1 (1)
(b)	[E(X) =] $-2\times\frac{1}{4}+1\times\frac{1}{6}+3\times\frac{1}{3}+4\times\frac{1}{12}+6\times\frac{1}{6}$ or $\frac{1}{12}(-6+2+12+4+12)$	M1
	$= \mathbf{2}$	A1 (2)
(c)	[E(X^2) =] $(-2)^2\times\frac{1}{4}+1\times\frac{1}{6}+3^2\times\frac{1}{3}+4^2\times\frac{1}{12}+6^2\times\frac{1}{6}$ (o.e.)	M1
	or $\frac{1}{12}(12+2+36+16+72)$ or $\frac{138}{12}$ or $\frac{23}{2}$ (o.e.)	
	[Var(X) =] $"\frac{23}{2}"-"2"^2 = \mathbf{7.5}$ (o.e.)	M1A1 (3)
Alt(c)	$E(X-\mu)^2 = (-2-"2")^2\times\frac{1}{4}+(1-"2")^2\times\frac{1}{6}+(3-"2")^2\times\frac{1}{3}+(4-2)^2\times\frac{1}{12}+(6-"2")^2\times\frac{1}{6}$	M1M1
	$= \mathbf{7.5}$ (o.e.)	A1 (3)
	Notes	**Total : 6**
(a)	B1 for $\frac{5}{6}$ or exact equivalents e.g. $\frac{10}{12}$ or $0.8\dot{3}$ isw	
(b)	M1 for an attempt at E(X) with at least 3 correct products seen. E(X) ÷5 (or n) is M0	
	May be seen as $-\frac{1}{2}+\frac{1}{6}+1+\frac{1}{3}+1$ or may be implied by 2	
	A1 2 cao (answer only 2/2 provided no incorrect method is seen)	
(c)	M1 for an attempt at E(X^2) with at least 3 correct products seen. May be seen as $1+\frac{1}{6}+3+\frac{4}{3}+6$ May be implied by $\frac{23}{2}$ oe E(X^2) ÷5 (or n) is M0	
	Allow expression even if labelled as Var(X)	
	M1 for using variance formula with correct substitution ft their E(X) and their E(X^2). May be implied by 7.5 provided a correct E(X^2) is seen	
	A1 for 7.5 or any exact equivalent e.g. $\frac{15}{2}$ (answer only 3/3 provided no incorrect method is seen)	
Alt(c)	M1 for an attempt at $E(X-\mu)^2$ with at least 3 correct products seen ft on their E(X).	
	May be seen as $4+\frac{1}{6}+\frac{1}{3}+\frac{1}{3}+\frac{8}{3}$. If answer ÷5 (or n) then M0	
	M1 for an attempt at $E(X-\mu)^2$ with all 6 correct products seen ft on their E(X).	
	May be seen as e.g $4+\frac{1}{6}+\frac{1}{3}+\frac{1}{3}+\frac{8}{3}$ If answer ÷5 (or n) then M0	
	A1 for 7.5 or any exact equivalent e.g. $\frac{15}{2}$	

Question Number		Scheme	Marks
2.	(a)	(Year 7 median =) 29 (Year 11 median =) 54	B1 B1 (2)
	(b)	(Lower quartile =) 22 (Upper quartile =) 42	B1 B1 (2)
	(c)	Year 7: $Q_3 - Q_2 > Q_2 - Q_1$, e.g. $13 > 7$, Positive skew Year 11: $Q_3 - Q_2 < Q_2 - Q_1$, e.g. $5 < 16$, Negative skew	M1 A1ft A1ft (3)
	(d)	skewed / not symmetrical oe **and** not continuous oe	B1dB1 (2)

	Notes	Total: 9
(a)	B1 cao B1 cao	
(b)	B1 cao B1 cao	
(c)	M1 for a comparison for either year using their values of Q_1, Q_2, and Q_3 e.g. may write $Q_3 - Q_2 > Q_2 - Q_1$ or allow qualitative comparisons e.g. "median is closer to the lower quartile (than the upper quartile)" but not "median is close to the lower quartile" as that is not a comparison condone slips in their calculations for this mark as long as the method is seen. Allow the comparison to be implied if both $Q_3 - Q_2$ and $Q_2 - Q_1$ calculations are seen. A1ft positive skew for Year 7 or ft their Q_1, Q_2, and Q_3 and following a correct comparison. If a calculation is seen it must be correct from their values from (a) and (b). Allow right skew. A1ft negative skew for Year 11 ft their Q_2 and following a correct comparison. If a calculation is seen it must be correct from their values from (a) and (b). Allow left skew.	
(d)	B1 for one valid reason (see below) dB1 dependent on the previous B mark. For two valid reasons (see below) Ignore reference to positive or negative, allow reference to not symmetrical instead of skewed and allow stating e.g. $Q_3 - Q_2 < Q_2 - Q_1$ provided it is correct for their values. Ignore irrelevant non-contradictory statements allow reference to discrete for not continuous (but not discrete uniform) and allow an explanation that a normal distribution requires continous data oe Do not allow a reason of mean $\neq$ median or $\neq$ mode unless the mean and/or mode is correctly found (mean (awrt 48.8) mode (63)) and median is 54 or 53 seen Do not allow "insufficient data points to make a model"	

Question Number	Scheme	Marks
3.(a)	$[S_{vs} =] 177.311 - \frac{36.8 \times 29}{8} = 43.911$ = awrt **43.9**	A1
		M1
	$[S_{ss} =] 209.72 - \frac{36.8^2}{8} = 40.44$ = awrt **40.4**	A1
		(3)
(b)	$r = \frac{"43.911"}{\sqrt{55.275 \times "40.44"}}$, $= 0.92875\ldots$ = awrt **0.929**	M1, A1
		(2)
(c)	e.g. r is close to 1 so there is support for the publisher's belief/data can be described as a linear regression	B1ft
		(1)
(d)	$b = \frac{"43.911"}{55.275}$, $= 0.7944\ldots$ = **awrt 0.79**	M1, A1
	$a = \bar{s} - b\bar{v} = \frac{36.8}{8} - "0.7944..." \times \frac{29}{8} = 4.6 - "0.7944..." \times 3.625$ [= 1.720…]	M1
	s =1.72 + 0.794v	A1
		(4)
(e)	$\frac{y}{1000} = "1.72" + "0.794" \times \left(\frac{x+50}{200}\right)$	M1
	y = 1920 + 3.97x	A1ft A1
		(3)
(f)	Gradient of textbooks is greater spend more advertising on textbooks	B1ft dB1ft
		(2)
		Total: 15

Notes

(a)

M1 for a correct expression for S_{vs} or S_{ss} may be implied by awrt 43.9 or awrt 40.4

A1 (for S_{vs} =) awrt 43.9

A1 (for S_{ss} =) awrt 40.4 or allow $\frac{1011}{25}$

Condone missing labels

(b)

M1 for a correct expression for r, ft their 43.911 (but not 177.311) and their 40.44 (not 209.72)

A1 for awrt 0.929 (note awrt 0.929 scores 2/2)

(c)

B1ft for saying it **does** support the belief oe **and** giving a suitable reason e.g. **strong** correlation or as r is close to 1 ft on their value for r.

If $|r|$<0.5 then allow e.g. "close to 0" so does not support oe

condone a reason that 0.929 is approximately 1

(d)	M1	for a correct expression for b, ft their 43.911 and allow 3sf values to be used. Implied by awrt 0.79
	A1	for awrt 0.79 or allow an exact fraction including the 3sf values e.g. $\frac{439}{553}$
	M1	for a correct method for a, ft their value of b scored for the values correctly substituted or implied by a correct equation
	A1	for **equation** for s in terms of v with a = awrt 1.72 and b = awrt 0.794
(e)	M1	for correct substitution into their equation. Must be in y and x. May attempt to find summary statistics in terms of x and y before finding the regression line y on x – in such cases it needs to be a fully correct method, allowing 1 slip but correct value for d
	A1ft	for d = awrt 3.97 (accept awrt 4.0) or $5 \times$ (their b) (correct to 2 sig. figs.) provided M1 is scored
	A1	for c = awrt 1920 (to 3sf) provided M1 is scored
(f)	B1ft	for a suitable comparison based on gradients, following through on their gradients Condone comparison of '3.97x' and '1.2x'. Must be a comparison not just stating a fact. Does not need to be in context. Ignore other statements provided they do not contradict the comparison Do not allow substituting in values unless it is used to compare gradients i.e. they would need to substitute in at two different values for x (or v) for both lines.
	dB1ft	dependent on the previous B mark. It is for recommending spend more on advertising textbooks (allow "yes" to mean spending more on advertising textbooks). **Must be consistent with their correct comparison from their equations.** **If gradient in (e) < 1.2 then a comparison of gradients leading to spending on novels.**

Question Number	Scheme	Marks
4. (a)	$[\mathrm{P}(S=1)=]\ 0$	B1 (1)
(b)	$[\mathrm{P}(S>2)=]1-\mathrm{P}(S=2)$ $=1-\left(\frac{2}{5}\times\frac{1}{4}\right)=\frac{9}{10}$ or $[\mathrm{P}(S>2)=]\mathrm{P}(S=3)+\mathrm{P}(S=4)+\mathrm{P}(S=5)$ $=\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}\times 2+\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}\times\frac{1}{2}\times 6+\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}$ $=\frac{1}{5}+\frac{3}{5}+\frac{1}{10}=\frac{9}{10}$	M1 M1 A1 (3)
Alt(b)	$[\mathrm{P}(S>2)=]\mathrm{P}$(at most one blue in first 2) $=\frac{3}{5}\times\frac{2}{4}+2\times\frac{3}{5}\times\frac{2}{4}=\frac{9}{10}$	M1 M1A1 (3)
(c)	$[\mathrm{P}(S=3)=]\left(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}+\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\right)=\frac{1}{5}$	M1 A1 (2)
(d)	$[\mathrm{P}(S=3\mid 2\text{nd is blue})=]\ \frac{\mathrm{P}(S=3\cap 2\text{nd is blue})}{\mathrm{P}(2\text{nd is blue})}=\frac{\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}}{\frac{3}{5}\times\frac{2}{4}+\frac{2}{5}\times\frac{1}{4}}=\frac{\frac{1}{10}}{\frac{2}{5}}=\frac{1}{4}$	M1 A1 (2)
(e)	$[\mathrm{P}(S\ =5)=]4\times\left(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}\times\frac{2}{2}\times\frac{1}{1}\right)=\frac{2}{5}$	B1 M1 A1 (3)
Alt(e)	$[\mathrm{P}(S=5)=]1-\mathrm{P}(2\leqslant S\leqslant 4)=1-\frac{1}{10}-\frac{1}{5}-\frac{3}{10}=\frac{2}{5}$	B1M1A1

	Notes	Total: 11
(a)	B1 cao	
(b)	M1 for writing or using $1-\mathrm{P}(S=2)$ or $\mathrm{P}(S=3)+\mathrm{P}(S=4)+\mathrm{P}(S=5)$. Condone $1-\mathrm{P}(S\leqslant 2)$	
	M1 for a correct expression for $\mathrm{P}(S=2)$ or $\mathrm{P}(S=3)+\mathrm{P}(S=4)+\mathrm{P}(S=5)$ Ignore labelling. May be implied by $\frac{1}{10}$ or $\frac{9}{10}$ but not if from an incorrect method. May see use of combinations e.g. $\frac{1}{{}^5C_2}$	
	A1 $\frac{9}{10}$ oe	
	Note: $\mathrm{P}(S>2)=\mathrm{P}(S=3)+\mathrm{P}(S=4)+\mathrm{P}(S=5)$ send to review	
Alt(b)	M1 for explaining or indicating that there is at most one blue in the first 2	
	M1 for a correct expression	
	A1 $\frac{9}{10}$ oe	

(c) M1 for both correct products (or 2 × ….) and no others. May see use of combinations e.g. $\frac{2}{{}^5C_2}$. May be implied by $\frac{1}{5}$ oe

Give benefit of the doubt if $\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}$ oe on its own is seen where the x2 is within the calculation of one product

A1 $\frac{1}{5}$ oe

(d) M1 for a correct ratio of probabilities expression (in symbols or described) or ft their values (num<denom).
Do not withhold this mark if they subsequently proceed to e.g. multiply $\mathrm{P}(S=3)$ and P(2nd is blue) in the numerator (assuming independence)
May see use of combinations e.g. $\frac{1}{{}^4C_1}$. May be implied by $\frac{1}{4}$ oe

A1 $\frac{1}{4}$ oe

(e) B1 for $\times 4$ or the sum of 4 identical products

M1 for any one product correct. May use combinations e.g. $\frac{1}{{}^5C_2}$

A1 $\frac{2}{5}$ oe (note correct answer scores 3/3)

Alt(e)

B1 for writing $1-\left(\mathrm{P}(S=2)+\mathrm{P}(S=3)+\mathrm{P}(S=4)\right)$ oe Condone $1-\mathrm{P}(S\leqslant 4)$

M1 for an attempt at the three terms with at least one product correct

A1 $\frac{2}{5}$ oe (note correct answer scores 3/3)

NOTE:

s	2	3	4	5
$\mathrm{P}(S=s)$	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{3}{10}$	$\frac{2}{5}$

Note Allow MR using 5 + 2 socks. Deduct up to 2 A1 marks

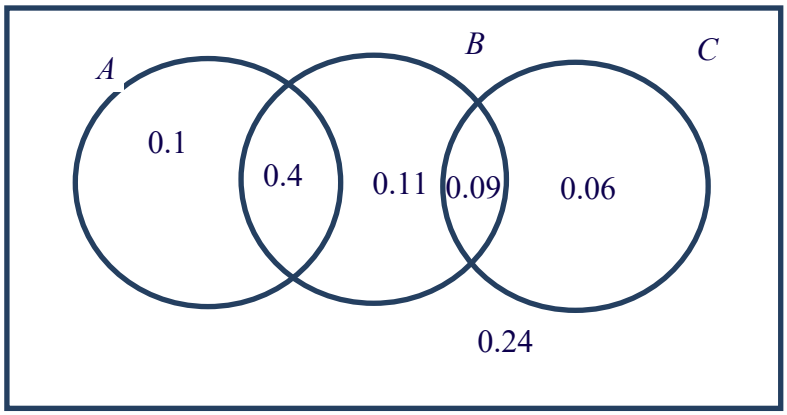
Question Number	Scheme	Marks
5(a)	$0.9 < x \leq 1.1$ group - width **0.5** (cm)	B1
	e.g. 1.5 (cm^2) is 2 seeds <u>or</u> 6.75 (cm^2 is 9 seeds) <u>or</u> $0.5c = 6.75$ oe <u>or</u> 45 <u>or</u> $\frac{10}{3}$	M1
	$0.9 < x \leq 1.1$ group - height **13.5** (cm)	A1 (3)
(b)	The data are continuous oe	B1 (1)
(c)	Mean $= \frac{67.8}{48} = 1.4125$ awrt 1.41 condone $\frac{113}{80}$	B1
	$\sigma = \sqrt{\frac{101.56}{48} - \left("\frac{67.8}{48}"\right)^2} = 0.347...$ awrt 0.347 (s = awrt 0.351)	M1dM1A1 (4)
(d)	Median $=[1.3]+ \frac{3}{11}\times 0.2$ allow $(n+1) = [1.3] + \frac{3.5}{11}\times 0.2$	M1
	= awrt **1.35** (or if using $(n+1)$ allow awrt 1.36)	A1 (2)
(e)	$\frac{27}{48} = \frac{9}{16}$ or 0.5625 or 0.563	B1 (1)
(f)	Mean increases **AND** standard deviation decreases e.g. the 0.95 increases to 1.4 and is now closer the mean	B1 dB1 (2)

	Notes	Total: 13
(a)	B1 correct width. May see width = 1.5 copied from the question so look for subsequent work which appears to be their width if not clearly labelled	
	M1 for attempting to find the scale factor. A correct equation in any form scores this mark e.g. $\frac{1.5}{2} = \frac{0.5h}{9}$. Also score for sight of 6.75 ignore any labelling May use the formula height of class $= k \times \frac{\text{frequency}}{\text{class width}} \Rightarrow 1 = k\left(\frac{2}{2.7-2.1}\right)$ Score for sight of $\frac{10}{3}$ or 45 which may also be seen in $\frac{\frac{10}{3}}{1} = \frac{45}{h}$ May be implied by a correct height.	
	A1 correct height	
(b)	B1 for a valid reason that the data are continuous oe e.g. allow not discrete Do not allow continuous <u>uniform</u> distribution	
(c)	B1 awrt 1.41 – cannot be scored if only seen within the calculation for the variance. Condone as a fraction but not $\frac{67.8}{48}$	

	M1	attempt at $\frac{101.56}{48} - \mu^2$ no need for square root (allow s). May attempt $\sum fy^2$ using the table – look for an attempt with at least 3 correct products. May be implied by awrt 0.12 or $\frac{2317}{19200}$ or if s then $\frac{2317}{18800}$. May be implied by awrt 0.35
	dM1	dep on previous method mark for using $\sqrt{\frac{101.56}{48} - \mu^2}$ allow s May be implied by awrt 0.35
	A1	awrt 0.347 (or if using sample sd then awrt 0.351)
(d)	M1	for a correct fraction: $[1.3] + \frac{3}{11} \times 0.2$ or $m = 1.5 - \frac{8}{11} \times 0.2$ or alternatively allow the equation: $\frac{24-21}{m-1.3} = \frac{11}{0.2}$ oe May be implied by $\frac{149}{110}$ May be implied by awrt 1.35 or if using n+1 then awrt 1.36
	A1	awrt 1.35 (note 1.3545 may be rounded to 1.355 which is fine) If using (n+1) then allow awrt 1.36) Do not accept a fraction
(e)	B1	awrt 0.563
(f)	B1	for suggesting the mean increases and sd decreases
	dB1	dependent on the previous B mark. Gives **complete** reasoning why the mean increases and sd decreases. May refer to $\sum fy$ increasing which increases the mean instead of specifically referencing 0.95 condone use of e.g. close for closer ignore any non-contradictory statements

Question Number	Scheme	Marks
6. (a)	$[\mathrm{P}(A < 388) = 0.001 \Rightarrow] \quad \frac{388-\mu}{\sigma} = \pm z$ (where $\lvert z\rvert > 2.25$) So $388 - \mu = -3.0902\sigma$ (o.e.)	M1
	$[\mathrm{P}(A > 410) = 0.0197 \Rightarrow] \quad \frac{410-\mu}{\sigma} = \pm z$ (where $1 < \lvert z\rvert < 2.5$) So $410 - \mu = 2.06\sigma$ (o.e.)	M1
	So $22 = 5.1502\sigma$ (calc gives 5.1502323…) $\Rightarrow \mu = ..., \ \sigma = ...$	dM1
	σ = 4.2716… (awrt **4.27**) and μ = 401.20… (awrt **401**)	A1, A1
		(5)
(b)	[Let X = profit in £]	
	x : -100, -0.30, 0.25	M1
	$\mathrm{P}(X = x)$: 0.001, 0.0197, $1 - (0.001 + 0.0197) = 0.9793$	M1
	$\mathrm{E}(X) = -100\times0.001 - 0.30\times0.0197 + 0.25\times\text{"0.9793"}$	M1
	= 0.138915… awrt (**£) 0.14**	A1
		(4)

	Notes	Total: 9
(a)	M1 for an attempt to standardise with 388 and set equal to $\pm$ a z value where $\lvert z\rvert > 2.25$	
	M1 for an attempt to standardise with 410 and set equal to $\pm$ a z value where $1 < \lvert z\rvert < 2.5$	
	Note standardisation is required so M1M1 is required to score dM1A1A1	
	dM1 dependent on both of the previous Ms. For solving their 2 linear equations and proceeding to values for σ and μ	
	You do not need to check the mechanics of solving which may be via a calculator. May be implied by correct values for σ and μ	
	A1 for σ = awrt 4.27 (must come from accurate z-values – 3sf or better seen somewhere in their solution)	
	A1 for μ = awrt 401 Note (M1M1M1A0A1 is possible)	
	Note that if they form two the equations $388 - \mu = 3.0902\sigma$ and $410 - \mu = -2.06\sigma$ this leads to σ = awrt -4.27 μ = awrt 401 which is A0A0	
(b)	M1 for 3 **correct** values of x including signs which may be embedded in a calculation	
	M1 for an attempt to find P(388<A<410) (correct numerical expression for 0.9793) or implied by 0.9793 Look out for valid attempts at using their part (a) and standardising to find P(388<A<410) which can still score this mark.	
	M1 dep on any 3 values of X and 3 probs. For an expression for E(X) using their value for P(388<A<410) condone sign slips for this mark	
	A1 for awrt 0.14 (so don't insist on 2dp). Condone awrt 14p Accept 0.13 if correct answer is seen beforehand	

Question Number	Scheme	Marks
7(a)	$P(A \cap B) = 0.4$	B1
	$P(A \mid B) = \dfrac{0.4}{P(B)}$	
	$\dfrac{0.4}{P(B)} = \dfrac{2}{3}$	M1
	$P(B) = 0.6$	A1
		(3)
(b)	$P(A' \mid B') = \dfrac{0.5+0.4-0.6}{0.4} = \dfrac{3}{4}$ or $\dfrac{"0.24"+"0.06"}{0.4} = \dfrac{3}{4}$	M1A1
		(2)
(c)	$P(B \cap C) = 0.6 \times 0.15$	M1
	$= 0.09$	A1
		(2)
(d)		M1 M1 M1 A1ft A1
		(5)
		Total 12

	Notes
	Mark parts (a), (b), (c) and (d) together. If there is a contradiction between the Venn diagram and the relevant part then the answer stated in the relevant part takes precedence.
(a)	B1 $P(A \cap B) = 0.4$ oe may be implied by further work. May be seen on the Venn diagram in (d) M1 sets $\dfrac{\text{their } 0.4}{P(B)} = \dfrac{2}{3}$ (must be numerical) May be implied by 0.6 A1 $[P(B) =]$ 0.6 oe (correct answer with no incorrect working seen 3/3)

(b) M1 May attempt e.g.

$$\frac{P(A' \cap B')}{P(B')} = \frac{P(A') + P(B') - P\left((A \cap B)'\right)}{P(B')} = \frac{1 - \left(P(A) + P(B) - P(A \cap B)\right)}{P(B')}$$

OR $\dfrac{P(C \cap B') + P((A \cup B \cup C)'))}{P(B')}$

Must see the values substituted in

e.g. $\dfrac{0.5 + \text{their } 0.4 - \text{their } 0.6}{1 - \text{their } 0.6}$ or $\dfrac{1 - (0.5 + \text{their } 0.6 - \text{their } 0.4)}{\text{their } (0.1 + 0.24 + 0.06)}$

or $\dfrac{\text{their } 0.24 + \text{their } 0.06}{\text{their } (0.1 + 0.24 + 0.06)}$

provided num<denom and both are probabilities

A1 $\frac{3}{4}$ oe (correct answer with no incorrect working seen scores 2/2)

(c) M1 their (a) × 0.15 (provided 0 < their (a) < 1) – may be implied by their 0.09. You may need to check this on your calculator.

A1 0.09 oe (correct answer with no incorrect working seen scores 2/2). Allow to be scored if seen on the Venn diagram in (d)

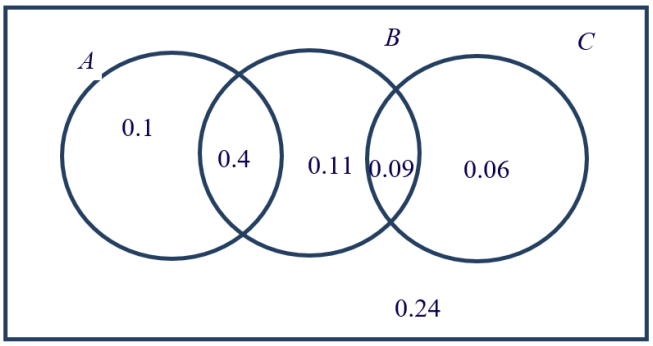
(d) M1 3 overlapping circles labelled A, B and C oe where $P(A \cap C)=0$ See main scheme diagram. May appear in a different order. Condone two of the circles to be labelled implying the labelling of the third.
M0 if one circle lies entirely inside another or if one is entirely separate (usually C) Do not allow blanks as zeros.

M1 for the two sections of C look for $P(B \cap C) =$ their 0.09 **and** $P(C \cap B') = 0.15 -$ their 0.09 from (c) both non-zero

M1 for the two sections of A look for $P(A \cap B) =$ their 0.4 from (a) and $P(A \cap B') = 0.5 -$ their 0.4 from (a) both non-zero

A1ft **dep on all previous method marks.** For 0.24 or prob outside so that all 6 probs add to 1 or ft on their diagram

A1 all correct including a box and all three labels.



Note: No labels allow access to 2nd and 3rd M1 marks ONLY