

Question Number	Scheme	Marks
1. (a)	$[S_{wt}] = 784 - \frac{119 \times 42}{6} =, -49$ $[S_{tt}] = 2435 - \frac{119^2}{6} =, 74.8\dot{3}$ or $74\frac{5}{6}$ or $\frac{449}{6}$ (accept awrt 74.8)	A1 M1 A1 (3)
(b)	$S_{ss} = 5 \times 10^7$ or <b>50 000 000</b> (o.e.) $S_{st} = -49 000$	B1 B1ft (2)
(c)	$r = \frac{-49}{\sqrt{50 \times 74.8\dot{3}}}$ or $\frac{-49000}{\sqrt{5 \times 10^7 \times 74.8\dot{3}}}$ =, -0.80105... = awrt <b>-0.801</b>	M1, A1 (2)
(d)	$r$ is close to -1 or $ r $ is close to 1 or “strong” (o.e.) [negative] correlation ... so “yes” or does support the belief	B1ft (1)
(e)	$b = \frac{-49}{74.8\dot{3}} = [-0.6547...]$ , $a = \frac{42}{6} - b \times \frac{119}{6} = [19.9866...]$ or $a = 7 - b \times 19.8\dot{3}$ So <b>w = 20.0 - 0.655t</b>	M1, M1 A1 (3)
(f)	<b>s = 20 000 - 655t</b> or <b>c = 20 000</b> and <b>d = -655</b>	B1ft B1ft (2)
(g)	Decrease in sales of [£] <b>655</b> (ignore any minus sign)	B1ft (1)
		<b>[14]</b>

	Notes
(a)	M1 for a correct expression for $S_{wt}$ or $S_{tt}$ (May be implied by either correct answer) 1 <sup>st</sup> A1 for $[S_{wt}] = -49$ 2 <sup>nd</sup> A1 for $[S_{tt}] = \text{awrt } 74.8$   SC If <u>both</u> values correct but clearly mislabelled award M1A0A1
(b)	2 <sup>nd</sup> B1ft for multiplying their $S_{wt}$ by 1000
(c)	M1 for a correct expression using their values provided $S_{tt}$ and $S_{ss}$ both > 0 A1 for awrt -0.801 (Correct ans. only M1A1, -0.80 with no working M1A0)
(d)	B1ft for a correct comment that uses their <u>value</u> of $r$ as support, provided $0.5 \leq  r  \leq 1$ For $ r  < 0.5$ comment must be “does <u>not</u> support”, because “weak” (o.e.) correlation. <b>NB</b> “points lie close to a straight line” is B0 unless supported by mention of their value of $r$
(e)	1 <sup>st</sup> M1 for a correct expression for $b$ or awrt -0.66 or -0.65 Ft their answers from (a) 2 <sup>nd</sup> M1 for a correct expression for $a$ ft their value for $b$ A1 for a correct equation in $w$ and $t$ only with $a = 20$ or awrt 20.0 and $b = \text{awrt } -0.655$ (No fractions) <b>If their <math>a</math> and <math>b</math> are given to more than 3 sf, accept answers in (f) to 3sf or better.</b>
(f)	1 <sup>st</sup> B1 ft for correct $c$ or “their $20.0 \times 1000$ ” 2 <sup>nd</sup> B1ft for correct $d$ or their “ $-0.655 \times 1000$ ” Values can be in an $s, t$ eq’n or $c =, d =$ (Their $a$ and $b$ needn’t be to 3 sf and ft their letter for $t$ )
(g)	B1ft for stating clearly <u>both</u> decrease (o.e.) <u>and</u> [£] 655. Ft their $d$ and allow “increase” if $d > 0$

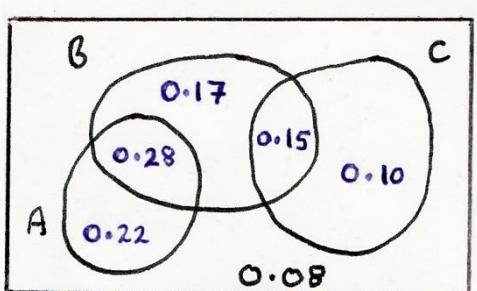
Question Number	Scheme	Marks
2. (a)	Width ( $w$ ) = <u>4</u> cm Areas: $16 \text{ cm}^2$ represents 32 offices (o.e.) or their $h = \frac{6}{\text{their } w}$ (3sf) or $\frac{8}{3.2} \times 0.6$ So height ( $h$ ) = <u>1.5</u> cm	B1 M1 A1 (3)
(b)	e.g. $(45) + \frac{20}{25} \times 5$ or $(50) - \frac{5}{25} \times 5$ (o.e.) ; = (f) <u>49</u>	M1; A1
(c)	$\frac{\sum fy}{90} = \frac{4420}{90}$ , = (f) <u>49.11</u> (or better) (Allow $\frac{442}{9}$ or $49\frac{1}{9}$ )	M1, A1
(d)	$\sqrt{\frac{226687.5}{90} - \bar{x}^2} = \sqrt{106.8487...}$ , = 10.3367 = awrt (f) <u>10.3</u>	M1, A1
(e)	Mean $\approx$ median so distribution is symmetric (no skew or very little skew) [Allow mean $>$ median or $k(\bar{x} - Q_2)$ ( $k > 0$ ) so +ve skew if compatible with their figures] [If using quartiles we must see $Q_1 = 44.0$ and $Q_3 = 55.5$ used]	B1ft
(f)	Symmetric (or little skew) so <u>normal (or Rika's suggestion) may be suitable</u>	B1ft
(g)	$\frac{c-50}{10} = 0.8416$ [N.B. use of $(1 - 0.8416)$ is B0] $c = 58.416$ = (f) <u>58.42</u> awrt <u>58.4</u>	M1, B1 A1 (3)

### Notes

(a)	M1 for a correct calculation of areas $1 \text{ cm}^2 = 2$ offices (o.e.) A1 for $h = 1.5$ cm (Correct answer only 2/2)
(b)	M1 for a correct expression without end point. Allow " $n + 1$ " so e.g. $(45) + \frac{20.5}{25} \times 5$ A1 for 49 or, if $(n + 1)$ used, allow 49.1 (Correct answer of 49 only 2/2)
(c)	M1 for an attempt at $\frac{\sum fy}{90}$ with at least 3 correct products of $\sum fy$ or $4000 \leq \sum fy \leq 5000$ A1 for 49.11 (Allow 49.1 from correct working) (Correct answer only 2/2, 49.1 only M1A0)
(d)	M1 for a correct expression including $\sqrt{...}$ , ft their mean. Allow use of $s$ A1 for awrt 10.3 Allow $s = \text{awrt } 10.4$ if clearly used. [NB use of 49.1 gives 10.389 $\Rightarrow$ A0 (Correct answer of 10.3 with no working is 2/2)
(e)	B1ft for reason and "symmetric" (or other correct) statement [Allow positive skew] Allow ft of their (b) and their (c). For "symmetric" need $ \bar{x} - Q_2  < 1$ "correlation" is B0
(f)	B1ft Suggest normal is or isn't suitable <b>with</b> suitable reason based on (e) or mean and med
(g)	M1 for stand'ing using "c", 50 and 10 and setting equal to $\pm z$ value where $0.84 \leq z \leq 0.85$ B1 for using $z = \pm 0.8416$ or better (calc gives 0.8416212...) in standard' attempt e.g. $\sqrt{10}$ for 10 A1 for awrt 58.4 (accept 3sf here) (Ans only of awrt 58.4 is M1B0A1 but 58.416 or better is 3/3)

Question Number	Scheme	Marks
3. (a)	$p = P(B \cap C) = P(B) \times P(C) = 0.6 \times 0.25 = \underline{0.15}$ $q = [P(C) - p] = \underline{0.10}$	M1 A1 (2)
(b)	$r = 1 - 0.08 - [P(B) + q] = 1 - 0.08 - 0.6 - 0.1 \text{ (o.e.) or } 1 - 0.08 - (0.6 + 0.25 - p) = \underline{0.22}$	M1 A1cao (2)
(c)	$s = [P(A) - r] = \underline{0.28}$ $t = [P(B) - p - s \text{ or use } P(B \cap C') - s = 0.6 \times 0.75 - "0.28"] = \underline{0.17}$	B1ft B1ft (2)
(d)	$P(A) \times P(B) = 0.5 \times 0.6 = 0.3 \text{ which is not equal to } s (= 0.28)$ So $A$ and $B$ are <u>not</u> independent	M1 A1 (2)
(e)	$\frac{(s+p) \text{ or } (0.6-t)}{P(A \cup C) \text{ or } [P(A) + P(C)] \text{ or } (r+s+p+q)} = \frac{("0.28" + "0.15") \text{ or } (0.6 - "0.17")}{0.5 + 0.25}$ $= \frac{43}{75}$	M1, A1ft A1 (3)

[11]

Notes		
(a)	M1 for a correct expression (using independence) for $p$ or 0.15 A1 for $q = 0.10$ (both correct 2/2)	
(b)	<b>Mark (b) &amp; (c) together</b> M1 for a correct expression for $r$ using $P(B \cup C)$ . Can ft their $q \in [0, 0.32]$ A1cao for $r = 0.22$ (correct ans only 2/2)	
(c)	1 <sup>st</sup> B1ft for $s = 0.28$ or 0.5 – their “0.22” 2 <sup>nd</sup> B1ft for $t = 0.17$ or 0.6 – their “0.15” – their “0.28”	
ALT	<b>Find <math>t</math> then <math>s</math> then <math>r</math></b>	<b>Fully correct Venn diagram will score the first 6 marks</b> <b>If text and VD disagree use text values</b>
(c)	2 <sup>nd</sup> B1ft for $t = 0.17$ [ from $1 - 0.08 - P(A) - P(C)$ ] 1 <sup>st</sup> B1ft for $s = 0.28$ or $P(B) - "0.17" - "0.15"$	
(b)	M1 for $r = P(A) - s$ and the A1 for 0.22	
$s = 0.3$	<b>They assume <math>A</math> and <math>B</math> are independent and get <math>s = 0.3</math> [from <math>P(A) \times P(B)</math>]</b>	
(c)	1 <sup>st</sup> B0 for $s = 0.3$ BUT can get 2 <sup>nd</sup> B1ft for either case in the scheme	
(b)	M1 for $r = P(A) - s$ BUT then A0cao for $r = 0.2$	
(d)	M1 for a correct $P(A) \times P(B) = 0.5 \times 0.6$ or 0.3 and a clear comparison with their $s (\neq 0.3)$ Or calculation of $P(A / B) = \frac{7}{15}$ or 0.467 or $\frac{\text{their } s}{0.6}$ and comparison with $P(A) = 0.5$ (o.e.) A1 dep. on M1 being earned and clear statement that $A$ and $B$ are <u>not</u> independent	
SC $s = 0.3$	dep on 1 <sup>st</sup> B1ft for $s = 0.5 - 0.2$ in (c); for correct calc. and conclusion seen (B1). On open M0A1	
(e)	M1 for a correct ratio expression of probs: num. < den. Allow $1 - (0.08 + \text{their } "t")$ on den. Any sight of multiplication on the numerator e.g. $0.6 \times 0.75$ is M0 1 <sup>st</sup> A1ft for correct ratio or ft using their values in numerator but correct denominator. 2 <sup>nd</sup> A1 for $\frac{43}{75}$ or accept awrt 0.573	

Question Number	Scheme	Marks
4.	<p>(a) <math>a = \frac{1}{3}</math> and <math>e = 1</math></p> $c = \left[1 - \frac{5}{6}\right] = \frac{1}{6}$ $\frac{1}{3} + 2b = \frac{5}{6} \quad \text{or} \quad \frac{1}{3} + 2b + \frac{1}{6} = 1$ $\Rightarrow b = \frac{1}{4}$ $d = a + b = \frac{1}{3} + \frac{1}{4} \quad \text{or} \quad d = \frac{5}{6} - \frac{1}{4} \quad (\text{o.e.}) \quad \text{so} \quad d = \frac{7}{12}$	B1 B1 M1 A1 B1ft (5)
(b)	$\left[ P(X^2 = 1) = a + b = \right] \frac{7}{12}$	B1ft (1) [6]

### Notes

**Probabilities not in [0, 1] score 0 for corresponding A or B marks**  
**Allow exact decimals or equivalent fractions**

(a) In part (a) you may see answers in the tables.  
If answers in the table and answers on the page disagree take the answers on the page.  
If jumbled working is followed by a list of answers on the page mark the list.  
M1 for an equation for  $b$ . Follow through their value of  $a$  and possibly  $c$  if both in [0,1]  
Must be seen as an equation with  $b$  the only unknown.  
NB  $b = d - a$  is not a suitable equation and use of this is M0  
1<sup>st</sup> A1 for  $b = \frac{1}{4}$  or 0.25 (Correct answer only is 2/2)  
3<sup>rd</sup> B1ft for  $d = \frac{7}{12}$  or their  $a +$  their  $b$  but their  $d$  must satisfy  $\frac{1}{3} < d < \frac{5}{6}$

(b) B1ft for  $\frac{7}{12}$  or their  $a +$  their  $b$  or their  $d$

**Please check the two B1ft marks carefully**

Question Number	Scheme	Marks
5. (a)	$P(T > 20) = P\left(Z > \frac{20-18}{5}\right)$ $P(Z > 0.4) = 1 - 0.6554$ $= \underline{0.3446} \text{ or awrt } \underline{0.345}$	M1 M1 A1 (3)
(b)	<p>Require <math>P(T &gt; 20   T &gt; 15)</math> or <math>\frac{P(T &gt; 20)}{P(T &gt; 15)}</math></p> $\frac{"(a)"}{P(Z > \frac{18-15}{5})} = \frac{"(a)"}{P(Z > -0.6)}, = \frac{"0.3446"}{0.7257} \text{ or } \frac{"0.345"}{0.726}$ $= 0.47485\dots = \text{awrt } \underline{0.475}$	M1 M1, A1ft A1 (4)
(c)	$P(T > d   T > 15) = 0.5 \text{ or } P(T < d   T > 15) = 0.5$ $P(T > d) \text{ or } P(15 < T < d) = 0.5 \times "0.7257" = [0.36285]$ $P(T < d) = "0.63715"$ <p>So <math>\frac{d-18}{5} = 0.35</math> (calculator gives 0.35085...)</p> $d = 19.754\dots = \text{awrt } \underline{19.8}$ <p>(Accept 19 mins 45(secs) or 19:45 but 19.45 is A0)</p>	M1 A1ft M1 A1 A1cso (5)
	<b>[12]</b>	
	<b>Notes</b>	
(a)	$1^{\text{st}}$ M1 for standardising with 20, 18 and 5. Accept $\pm$ $2^{\text{nd}}$ M1 for attempting $1 - p$ [where $0.5 < p < 0.7$ ]. Beware $1 - 0.4$ (or their $z$ value) is M0 A1 for awrt 0.345 (Correct ans only 3/3)	
(b)	$1^{\text{st}}$ M1 for either correct conditional probability statement (allow "in words" or any letter except $Z$ ) $1^{\text{st}}$ M1 can be implied by $2^{\text{nd}}$ M1 so a mark of M0M1 should not be given. $2^{\text{nd}}$ M1 for using their (a) on num. and attempting to standardise $P(T > 15)$ (no $\pm$ on denom. Num.>Deno. is M0 Allow one digit transcription errors from (a) e.g. 0.3464 or 0.3466 etc for $2^{\text{nd}}$ M1 and $1^{\text{st}}$ A1ft $1^{\text{st}}$ A1ft for their 0.3446 on numerator and denominator of 0.7257 (or better: 0.7257469...) provided Num < Denom. Allow 0.726 on the denominator Sight of $\frac{"0.3446"}{0.7257 \text{ or } 0.726}$ will score M1M1A1ft $2^{\text{nd}}$ A1 for awrt 0.475	
(c)	$1^{\text{st}}$ M1 for a correct conditional probability statement that includes the 0.5 $1^{\text{st}}$ A1ft for $P(T > d)$ or $P(15 < T < d) = 0.5 \times$ their $P(T > 15)$ [provided $P(T > 15) > 0.5$ ] Follow through (3sf) their $P(T > 15) = 0.7257$ or better from part (b). (Allow 0.726) Sight of $0.5 \times$ their 0.7257 = "0.36285" or better scores $1^{\text{st}}$ M1 and $1^{\text{st}}$ A1ft (Allow 0.363) $2^{\text{nd}}$ M1 (dep on $1^{\text{st}}$ M1) for $P(T < d) = 1 - "0.36285"$ or "0.36285" + 1 - "0.7257" $= [0.6371 \sim 0.6372]$ Sight of their 0.63715 or better (calc: 0.637126...) scores first 3 marks (Allow 0.637) $2^{\text{nd}}$ A1 for $\frac{d-18}{5} = 0.35$ (or better) (Calc could give 0.350788...) $3^{\text{rd}}$ A1cso for ( $d =$ ) awrt 19.8 (accept 19.7 not awrt 19.7) <b>Must</b> come from correct work.	
<b>Beware!</b>	$0.5 \times 0.7257 = 0.36285$ and using <u>this</u> (instead of 0.35) as $z$ value leads to 19.8 but is A0A0	

Question Number	Scheme	Marks														
6. (a)	$[E(X)] = [0 \times \frac{1}{12}] + 3 \times \frac{2}{3} + 6 \times \frac{1}{4} , = \underline{\frac{7}{2}} \text{ or } \underline{\underline{3.5}}$	M1, A1 (2)														
(b)	$[E(X^2)] = [0^2 \times \frac{1}{12}] + 3^2 \times \frac{2}{3} + 6^2 \times \frac{1}{4} (= 15)$ $[Var(X)] = "15" - \left(\frac{7}{2}\right)^2$ $= \underline{\frac{11}{4}} \text{ or } \underline{\underline{2.75}}$	M1 M1 A1 (3)														
(c)	$5p + 2(1-p) = 3 \quad \underline{\text{or}} \quad [\text{allow } p+q=1 \text{ and } 5p+2q=3 \text{ for M1}]$ So $p = \frac{1}{3}$ (*)	M1A1 A1 cso (3)														
(d)	$P(Y=2) = \frac{2}{3} \text{ and } P(Y=5) = \frac{1}{3}$	B1 (1)														
(e)	$P(S=30) = P(X=6 \text{ and } Y=5)$ $= \frac{1}{4} \times \frac{1}{3} = \frac{1}{12}$	M1 A1cso (2)														
(f)	<table border="1"> <tr> <td><math>[s]</math></td> <td>4</td> <td>6</td> <td>12</td> <td>15</td> <td>25</td> <td>(30)</td> </tr> <tr> <td><math>[P(S=s)]</math></td> <td><math>\frac{2}{36}</math></td> <td><math>\frac{16}{36}</math></td> <td><math>\frac{6}{36}</math></td> <td><math>\frac{8}{36}</math></td> <td><math>\frac{1}{36}</math></td> <td><math>\left(\frac{3}{36}\right)</math></td> </tr> </table>	$[s]$	4	6	12	15	25	(30)	$[P(S=s)]$	$\frac{2}{36}$	$\frac{16}{36}$	$\frac{6}{36}$	$\frac{8}{36}$	$\frac{1}{36}$	$\left(\frac{3}{36}\right)$	M1A1A1 (3)
$[s]$	4	6	12	15	25	(30)										
$[P(S=s)]$	$\frac{2}{36}$	$\frac{16}{36}$	$\frac{6}{36}$	$\frac{8}{36}$	$\frac{1}{36}$	$\left(\frac{3}{36}\right)$										
(g)	$E(S) = \frac{1}{36}[4 \times 2 + 6 \times 16 + 12 \times 6 + 15 \times 8 + 25 \times 1 + 30 \times 3]$ $= \underline{11\frac{5}{12}} \text{ or } \underline{\frac{137}{12}} \text{ or } \underline{11.41\dot{6}}$	M1 A1 (2)														
(h)	$E(X^2) = 15$ and $E(S) = 11.416\dots$ or $E(X^2) > E(S)$ ... so <u>Charlotte</u> has the higher total score	B1ft dB1ft (2)														

### Notes

(a)	M1 for a fully correct expression (allow missing 0 term). Correct ans only is 2/2
(b)	1 <sup>st</sup> M1 for a fully correct expression (allow missing 0 term) for $E(X^2)$ . Allow $Var(X)$ label 2 <sup>nd</sup> M1 for their $E(X^2) - \text{their } E(X)^2$
(c)	1 <sup>st</sup> M1 for attempting a linear eq'n in $p$ (or $x$ etc). Must see $= 3$ and have 2 terms in $p$ , 1 correct 1 <sup>st</sup> A1 for a fully correct equation for $p$ <u>or</u> for solving their eqns leading to correct eqn in $p$ 2 <sup>nd</sup> A1 for $p = \frac{1}{3}$ with M1 scored and no incorrect working seen.
(d)	B1 for correct values for $P(Y=2)$ and $P(Y=5)$ . Needn't be in formal table but labelled.
(e)	M1 for $6 \times 5 = 30$ <u>or</u> $P(30) = P(6,5)$ <u>or</u> $P(30) = P(6) \times P(5)$ <u>or</u> $S = (XY =) 6 \times 5$ <u>or</u> $X = 6$ and $Y = 5$ A1cso dep on M1 scored for with no incorrect working seen e.g. $30 = \frac{1}{3} \times \frac{1}{4}$ is A0
(f)	1 <sup>st</sup> M1 for an attempt at prob. distribution with at least 3 correct ( $s$ and $P(S=s)$ ) 1 <sup>st</sup> A1 for 6 correct $s$ values 2 <sup>nd</sup> A1 for a fully correct prob. distribution including $s = 30$
(g)	M1 for attempting $E(S)$ using their values. Must <u>see</u> ...3 products (correct ft) decimals to 3sf A1 for $11\frac{5}{12}$ <u>or</u> $\frac{137}{12}$ or any <u>exact</u> equivalent. (Correct ans. only 2/2, awrt 11.4 only M1A0)
(h)	1 <sup>st</sup> B1 for correct comparison of their $E(S)$ and $E(X^2)$ labelled in (b) or (h) [expressions or values] 2 <sup>nd</sup> d B1 dependent on a correct comparison of their values for choosing correct player.