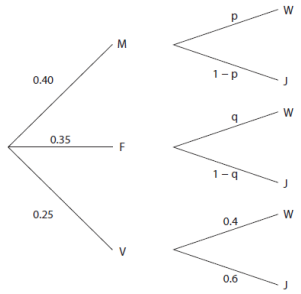
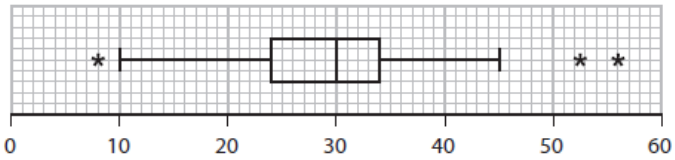
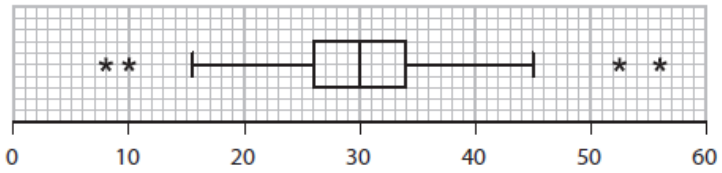
Question Number	Scheme	Marks
1.	$\begin{array}{\|c\|c\|c\|c\|c\|c\|}\hline x & -1 & 2 & 3 & 4 & 7 \\ \hline \mathrm{P}(X=x) & \frac{9}{k} & \frac{6}{k} & \frac{5}{k} & \frac{4}{k} & \frac{1}{k} \\ \hline \end{array}$	M1
	$\sum \mathrm{P}(X=x)=1 \Rightarrow \quad \frac{25}{k}=1$	M1
	$k=25$	A1
	$\mathrm{E}(X)=\frac{1}{25}\left[-1\times 9+2\times 6+3\times 5+4\times 4+7\times 1\right]$	M1
	$=\underline{\underline{\frac{41}{25}}}$	A1
		[5]
	Notes	
	1st M1 for at least 3 correct probabilities in terms of k (may be seen used in expression for E(X)) 2nd M1 for attempting to use sum of 5 probs = 1 (ft their probabilities) 1st A1 for $k = 25$ (stated or used correctly) 3rd M1 for attempt at a correct expression at least 3 products (ft their k – value or letter) 2nd A1 for $\frac{41}{25}$ or exact equivalent e.g. 1.64 Correct answer with no incorrect method marks scores 5/5	

Question Number	Scheme	Marks
2. (a)		B1 B1 (2)
(b)	P(W) = 0.4p + 0.35q + "0.25"×0.4 [= 0.4p + 0.35q + 0.1]	B1ft (1)
(c)	Correct expression: $P(W \cap V) = "0.1" = "0.25" \times P(W)$ or $P(W) = P(W \mid V) = 0.4$ $0.1 = 0.25(0.4p + 0.35q + 0.25\times0.4)$ or $0.4p + 0.35q + 0.25\times0.4 = 0.4$	M1 A1 (2)
(d)	$\frac{7}{30} = \frac{0.35(1-q)}{"P(J)"}$ Since V and W are independent so are V and $W' = J$ so P(J) = 0.6 or sub P(J) = 1 – their (b) to get an equation in p and q [May see $8p - 23q + 12 = 0$] [So $1-q = \frac{2}{3}P(J)$ therefore] $\boldsymbol{q = 0.6}$ $8p + 7\times"0.6" = 6$ So $\boldsymbol{p = 0.225}$ or $\frac{9}{40}$	M1 dM1 A1 ddM1 A1 (5)
(e)	{P($V \mid W$) = P(V) = 0.25 (since independent) and P($M \mid W$) = 0.225 (= p)} P($F \mid W$) = $\frac{0.35\times"0.6"}{"0.4"}$ or $\frac{0.35q}{(b)}$; = $\frac{21}{40}$ or 0.525 [Since this prob > 0.5 therefore it must be the largest] so conclusion is correct Allow B1ft for comparing 3 calculated probs of the form P($M \cap W$) needn't be correct ft	M1 ;A1 B1ft (3) **[13]**

	Notes
(a)	1st B1 0.25 for P(V) 2nd B1 for correct probabilities on 2nd branches (1 – p), (1 – q) [allow their values] and 0.6
(b)	B1ft for a correct expression using their values from tree diagram
(c)	M1 for sight or use of a correct expression in V and W or correct equation in p and q (ft their part (b)) A1 for a fully correct equation (needn't be simplified) [may see 0.4p + 0.35q = 0.3 or 8p + 7q = 6]
(d)	1st M1 for using given conditional probability to form an equation in q and P(J) using $\frac{7}{30}$ 2nd dM1 (dep on 1st M1) for a getting P(J) = 0.6 or sub 1 – their (b) and get 2nd equation in p and q 1st A1 for q = 0.6 [NB must be q = 0.6 not just P(J) = 0.6] May see after 3rd M1 for solving with p 3rd ddM1(dep on both Ms) for seeing substitution of their 1st value to find the 2nd value (p or q) Allow ft of their p or q in one of their equations provided p and q both lie in (0, 1) 2nd A1 for p = 0.225 or exact equivalent After the 2nd M1, sight of p = 0.225 and q = 0.6 earns the final 3 marks
(e)	M1 for a method for finding P($F \mid W$) A1 for a correct value $\frac{21}{40}$ or exact equivalent B1ft for a correct conclusion based on enough probs found ft their probabilities

Question Number	Scheme	Marks
3. (a)	[D = distance achieved] $\mathrm{P}(D > 4.3) = \mathrm{P}\left(Z > \dfrac{4.3-3.8}{0.9}\right)$ or $\mathrm{P}(Z > 0.555\ldots)$	M1
	$= 1 - 0.7123$ (tables)	M1
	$= 0.2877$ (tables) or $0.289257\ldots$ (calc) awrt **0.288** or awrt **0.289**	A1
		(3)
(b)	$\dfrac{d-3.8}{0.9} = -0.8416$ (calc $-0.84162123\ldots$)	M1 ; B1
	$d = 3.0425\ldots$ awrt **3.04**	A1
		(3)
(c)	$\mathrm{P}(D > g \mid D > 4.3) = \dfrac{\mathrm{P}(D > g)}{\mathrm{P}(D > 4.3) \text{ or (a)}}$ $\left[= \dfrac{1}{3}\right]$ (o.e.)	M1
	$\therefore \mathrm{P}(D > g) = \frac{1}{3}\text{(a)} = 0.096419\ldots$	A1ft (o.e)
	$\dfrac{g-3.8}{0.9} = 1.302228\ldots$	dM1
	so $g = 4.97200..$ awrt **4.97** or awrt **4.98**	A1
		(4)
(d)	P(no gold medals) = $\left(\frac{2}{3}\right)^3$	M1
	P(at least one gold) = $1 - \left(\frac{2}{3}\right)^3$	M1
	$= \frac{19}{27}$	A1
		(3)
		[13]

	Notes
(a)	1st M1 for standardising 4.3 with 3.8 and 0.9 (allow $\pm$) 2nd M1 for $1 - p$ (where $0.7 < p < 0.8$) A1 for awrt 0.288 or 0.289 (calc. 0.289257) (correct answer only 3/3)
(b)	M1 for standardising with d, 3.8 and 0.9 and setting equal to a z value $0.8 < \lvert z\rvert < 0.9$ B1 for $z = \pm 0.8416$ or better used A1 for awrt 3.04 (condone $d \geqslant \ldots$)
Ans only	For awrt 3.0425 or 3.0426 score 3/3 For awrt 3.04 score M1B0A1
(c)	1st M1 for either expression for the conditional prob. [or sight of $\frac{1}{3}$(a)] (ft their answer to (a) to 2 sf) 1st A1ft for $\mathrm{P}(D > g) = 0.096$ or better (0.289 gives 0.09633… calc 0.096419…) The $\mathrm{P}(D > g)$ may be clearly shown on a diagram. 1st M1A1 can be awarded for $\mathrm{P}(D > g) = \frac{1}{3}$(a) or for $\mathrm{P}(D < g) = 1 - \frac{1}{3}$(a) [ft their (a) to 2 sf] 2nd dM1 (dep on 1st M1) for standardising with g, 3.8 and 0.9 and put equal to a z value where $\lvert z\rvert > 1$ 2nd A1 for awrt 4.97 or 4.98 (Correct answer with no incorrect working seen 4/4) (condone $g \geqslant \ldots$)
SC	**(Medals v Certificates)** 1st B1 for [$\mathrm{P}(D > g) =$] $\frac{1}{3} \times 0.8 = \frac{4}{15}$ or 0.267 (score as 1st M0 1st A1) 2nd B1 for g = awrt 4.36 (4.358 tables, 4.3606..calc) (score as 2nd M0 2nd A1)
(d)	1st M1 for a correct probability of no gold medals or 2 of: $3\left(\frac{2}{3}\right)^2 \times \frac{1}{3}$ or $3\left(\frac{1}{3}\right)^2 \times \frac{2}{3}$ or $\left(\frac{1}{3}\right)^3$ 2nd M1 for $1 - p^3$ or $3(p)^2(1-p) + 3p(1-p)^2 + (1-p)^3$ where $0 < p < 1$ A1 for $\frac{19}{27}$ (or exact equivalent) only e.g. $0.\dot{7}0\dot{3}$

Question Number	Scheme	Marks
4. (a)	Upper quartile = 34 Lower limit = 24 – 15 = 9 or upper limit is "34" + 15 = 49 So outliers are: 8, 52.5 and 56	B1 M1 A1ft, A1ft (4)
(b)		B1 B1 B1 (3)
(c)	$Q_2 - Q_1 (= 6) > ("4" =) Q_3 - Q_2$ or e.g. in words e.g. " Q_3 closer to Q_2 than Q_1 is" So negative (skew)	M1 A1ft (2)
(d)	IQR now "34" – 26 = 8 so new outlier limits are 26 – 1.5×"8" = **14** and "34" + 1.5×"8" = **46** 	M1 A1ft A1 (3)
(e)	[Q_1 has increased so both above 24 Median same so either side of or on median] So one **between 26 and 30** inc [Q_3 unchanged so must be either side of Q_3] so one **between "34" and 45** inc	B1 B1 (2) **[14]**

	Notes
(a)	B1 for Q_3 = 34 either stated or used/implied (score if seen on box plot) M1 for one correct calculation (ft their 34 for upper limit) [May be implied by correct outliers] 2nd A1ft for the lower **outlier** at 8 (ft their limit provided limit ⩽ 12) 3rd A1ft for upper **outliers** at 52.5 and 56 (ft their limit provided it is > 45) Award if their outliers are seen on box plot **NB These accuracy marks are for the outliers not the limits**
(b)	1st B1 for a box with Q_1 = 24, Q_2 = 30 Q_3 = their 34 and two whiskers one on each side. 2nd B1 for one lower whisker ending at 10 (or their 9) and outlier at 8 only 3rd B1 for one upper whisker ending at 45 (or their 49 to match "9") and outliers at 52.5 and 56 only
SC	**Extra whiskers. If one set of whiskers gives a correct box plot award B1B0B0** **Usual accuracy for plots – to within 0.5 of a square.**
(c)	M1 for correct comparison of $Q_2 - Q_1$ and $Q_3 - Q_2$ (ft their Q_3) (if no values seen must see comparison otherwise accept correctly assigned 6 and 4 without >) A1ft for correct deduction based on their Q_3 (+ve (skew) if their Q_3 > 36, no skew if their Q_3=36)
(d)	M1 for recognising new IQR and at least one correct new limit (ft their 34, implied by correct plot) 1st A1ft for a correct lower whisker ending at 15.5 (or their 14) and 2 correct outliers at 8 and 10 2nd A1 for a fully correct box plot with upper whisker to 45 (or could go to 46 [to match their 14])
SC	**Extra whiskers. If one set of whiskers gives a correct box plot award M1A0A1**
(e)	1st B1 for a range [26, 30] allow that (…) (o.e. eg between 26 and 30) 2nd B1 for a range [34, 45) condone […] or (…) (ft their 34 and allow o.e. e.g. between 34 and 45)

Question Number	Scheme	Marks
5. (a)	$y = 6.066 + 0.136\times 80$ $= 16.946$ (so annual rent is) **$ 16 946**	M1 A1 (2)
(b)	$S_{yy} = 3434 - \frac{183^2}{10}$ or $S_{xx} = 84\,818 - \frac{900^2}{10}$ $S_{yy} =$ **85.1** $S_{xx} =$ **3818**	M1 A1 A1 (3)
(c)	Need S_{xy} so use b so $S_{xy} = b\times S_{xx} = 0.136\times 3818$ or 519.248 $[r =] \frac{0.136\times "3818"}{\sqrt{"3818"\times "85.1"}}$ $= 0.9109448\ldots$ awrt **0.911**	M1; A1 M1 A1 (4)
(d)	Since (new $x = 90$ and [original or] new $\bar{x} = 90$) the term $(x - \bar{x})$ will be 0 Therefore (the 11th shop makes no change) S_{xy} stays the same	M1 A1 (2)
(e)	S_{xx} will be the same so b will be the same New $\bar{y} = \frac{183+15}{11} = 18$ (or a is reduced by 0.3) Equation is ***y* = 5.766 + 0.136*x***	M1 M1 A1 (3)
(f)	$x = 300$ is outside the range $300 \gg 90$ [$300 \gg 90 + 3\sigma = 90 + 3\times 18.63.. \approx 146$] So not suitable (since involves extrapolation) (o.e.)	B1 (1) **[15]**

	Notes
(a)	M1 for substituting $x = 80$ into the given equation A1 for awrt \$ 16 900 (or better)(allow "16.9 thousand dollars"). Must have some units. Condone $y =$
(b)	M1 for a correct expression for either (can be implied by sight of either correct answer) 1st A1 for 85.1 2nd A1 for 3818 or accept 3820
(c)	1st M1 for an attempt to use gradient of regression line to find S_{xy} 1st A1 for awrt 519 2nd M1 for a correct expression using their values (M0 if $S_{xy} = 900\times 183 = 164700$) 2nd A1 for awrt 0.911
(d)	M1 for stating or showing [old or] new $\bar{x}$ =90 (new $x = 90$ implied) or stating that $(x - \bar{x})$ term = 0 A1 for a fully correct argument mentioning new $x = \bar{x} = 90$ and that extra $(x - \bar{x})$ term = 0 Condone using $\bar{y} = 18.3$ instead of 18
(e)	1st M1 for a correct statement about S_{xx} or b (may be implied by 0.136 used correctly) 2nd M1 for a correct value for new $\bar{y}$ (calculation may be seen in (d) scores here when 18 is used) A1 for $y = 5.766$ (or awrt 5.77 or awrt 5.76) + $0.136x$ (correct equation scores 3/3)
(f)	B1 for suitable comparison (must see 300 vs 90 or 3000 vs 900) that says or implies that 300 will be outside the range and therefore not suitable. Not sufficient to just say "larger"

Question Number	Scheme	Marks
6. (a)	[E(A) =] $1\times0.4 + 4\times0.2 + 5\times0.25 + 7\times0.15$ $= \underline{\mathbf{3.5}}$ **(*)**	M1 A1cso (2)
(b)	$\left[\mathrm{E}(A^2)=\right]1\times0.4 + 4^2\times0.2 + 5^2\times0.25 + 7^2\times0.15$ [= 17.2] Var(A) = E(A^2) – [E(A)]^2 = 17.2 – 3.5^2 $= \underline{\mathbf{4.95}}$	M1 M1 A1 (3)
(c)	(Discrete) uniform (distribution)	B1 (1)
(d)	By symmetry $k = 6$	B1 (1)
(e)	$\left[\text{Sam has } Z=\frac{3.5-4}{3}=-\frac{1}{6} \text{ and}\right]$ Tim needs $\frac{3.5-A}{4}<-\frac{1}{6}$ so $A > 4.166..$ So prob = 0.25 + 0.15 = **0.4**	M1 A1 (2)
(f)	Need largest possible $\mu = 7$ and smallest possible $\sigma = 1$ P($X > 3.5$) is then $\mathrm{P}\left(Z>\frac{3.5-7}{1}\right)$ = P($Z > -3.5$) = **0.9998** (tables) or 0.999767…(calc)	B1, B1 M1 A1 (4)
(g)	[Need $A = 7$ and $B = 1$ (or ft from (f)) so] P($A = 7$)×P($B = 1$) or "0.15"×0.25 = **0.0375**	M1 A1cso (2) **[15]**

	Notes
(a)	M1 for an attempt at E(A) – at least 3 correct products seen A1cso for 3.5 or exact equivalent with no incorrect working seen and M1 scored
(b)	1st M1 for an attempt at E(A^2) – at least 3 correct products 2nd M1 for use of E(A^2) – [E(A)]^2 ft their value for E(A^2)
ALT	**M2** for $(-2.5)^2\times0.4 + (0.5)^2\times0.2 + (1.5)^2\times0.25 + (3.5)^2\times0.15$ (at least 3 correct products) A1 for 4.95 or an exact equivalent e.g. $\frac{99}{20}$
(c)	B1 for uniform (continuous uniform is B0)
(d)	B1 for stating $k = 6$ with a suitable reason e.g. mention of symmetry or full calculation
(e)	M1 for a suitable calculation for A e.g. $\frac{3.5-A}{4}<-\frac{1}{6}$ or stating $A = 5$ or 7 or $A >$ awrt 4.2 (o.e.) A1 for 0.4 (must be based on some correct calculation seen)
(f)	1st B1 for $\mu = 7$ may be implied from a standardisation with 3.5 seen 2nd B1 for $\sigma = 1$ may be implied from a standardisation with 3.5 seen M1 for attempting correct probability i.e. P(Z … or X…) ft standardisation using 3.5, their $\mu \neq 4$ and their $\sigma \neq 3$ but their μ and σ must be "possible" values or P($Z > -3.5$) A1 for 0.9998 or better
(g)	M1 for "0.15"×0.25 ft their value of A from (f) A1cso for 0.0375 or exact equivalent e.g. $\frac{3}{80}$ (Must clearly come from $A = 7$ and $B = 1$ in (f))

G. B. Attwood 2/11/20