Question Number	Scheme	Marks
1. (a)	[Area = k × frequency $\rightarrow$ $16.5 = k \times 12$ $\rightarrow$] Area = $\frac{16.5}{12} \times 18$ oe = **<u>24.75</u>** (cm^2)	M1 A1 (2)
(b)	fd method $\frac{24}{58-55}[=8]$ **and** $\frac{35}{55-50}[=7]$ **or** Area method $\frac{16.5}{12} \times 24[=33]$ **and** $\frac{16.5}{12} \times 35[=48.125]$ **or** $\frac{16.5}{12} \times \frac{24}{3}[=11]$ **and** $\frac{16.5}{12} \times \frac{35}{5}[=9.625]$ Let h = height of the 2nd tallest bar $[h=]\frac{10}{'8'} \times '7'$ **or** $[h=]\frac{"48.125" \times 10 \times 3}{5 \times "33"}$ **or** $[h=]"9.625" \times \frac{10}{"11"}$ = **<u>8.75</u>** (cm)	M1 dM1 A1 (3)
(c)(i)	$[Q_2=]50+\frac{7}{35} \times 5$ or $[Q_2=]55-\frac{28}{35} \times 5$ = **<u>51</u>** (cm)	M1 A1
(ii)	$[Q_3=]55+\frac{2}{24} \times 3$ or $[Q_3=]58-\frac{22}{24} \times 3$ **and** $"55.25"-45$ = **<u>10.25</u>** (cm)	M1 A1 (4)
(d)	$\frac{"55.25"-2("51")+45}{"55.25"-45}$ [= –0.17073… < 0] negative [skew].	M1 A1ft (2)
	Notes	**[11]**
(a)	M1 allow equivalent eg $16.5 \times \frac{3}{2}$ A1 for 24.75 allow 24.8	
(b)	M1 correct method for finding the frequency density or area for the highest **and** 2nd highest bars Allow if 8 and 7 seen or 33 and 48.125 seen or 9.625 rather than 48.125 and/or 11 seen rather than 33 dM1 dep on previous M mark awarded. A fully correct expression for h or a fully correct equation to enable h to be found eg $\frac{"33"}{10 \times 3} = \frac{"48.125"}{5h}$ A1 8.75 oe **NB** answer of 8.75 seen as final answer 3/3	
(c)(i)	M1 for $50+\frac{7}{35} \times k$ **or** $55-\frac{28}{35} \times k$ **or** $\frac{Q_2-50}{k} = \frac{60-53}{88-53}$ **or** $\frac{55-Q_2}{k} = \frac{88-60}{88-53}$ where 4,, k,, 6 oe (condone use of n + 1 ie 7.5 rather than 7, 27.5 rather than 28 or 60.5 rather than 60) A1 51 (condone for use of n + 1 awrt 51.1)	
(ii)	M1 $55+\frac{2}{24} \times t$ **or** $58-\frac{22}{24} \times t$ **or** $\frac{Q_3-55}{t} = \frac{90-88}{112-88}$ **or** $\frac{58-Q_3}{t} = \frac{112-90}{112-88}$ oe where 2,, t,, 4 **and** using $"\text{their } Q_3"-45$ (condone use of n + 1 ie 2.5 or 2.75 rather than 2, 21.5 or 21.25 rather than 22 or 90.5 or 90.75 rather than 90) A1 10.25 oe eg 41/4 allow 10.3 from correct working	

(d)	M1 substitution of their values from (c) seen **or** awrt –0.17 or –7/41 A1ft dependent on M1 being scored. Correct description of skewness consistent with their values from part (c) ignore the final answer if working shown. Only allow no skew or symmetrical if their value should be 0 Ignore correlation.

Question Number	Scheme	Marks
2. (a)	$[S_{tt} =]82\,873 - \frac{1361^2}{40}$ $[S_{ct} =]83\,634 - \frac{1634\times1361}{40}$ $[S_{tt} =]36\,564.975$ $[S_{ct} =]28\,037.15$	M1 A1 A1 (3)
(b)	$[r =]\frac{'28\,037.15'}{\sqrt{28\,732.1\times'36\,564.975'}} = 0.865...$ awrt **0.865**	M1 A1 (2)
(c)	In general, films with higher **cost** have higher ticket **sales**.	B1ft (1)
(d)	$[b =]\frac{'28\,037.15'}{28\,732.1}[= 0.9758\ldots]$ $[a =]\frac{1361}{40} - 'b'\times\frac{1634}{40}$ **or** $34.025 - "b"\times 40.85$ $t = -5.8369\ldots + 0.9758\ldots c$ * $t =$ awrt $-5.84 +$ awrt $0.976c$*	M1 M1 A1cso* (3)
(e)	$t = -5.84 + 0.976\times90$ $t =$ £82 million awrt **£82 million**	M1 A1 (2)
(f)	$-5.84 + 0.976c < 0.8c \rightarrow 0.176c < 5.84$ $c < 33.1818$ $c <$ awrt (£) **33.2**	M1 A1 (2)
	Notes	**Total 13**
(a)	Mark part (a) and (b) together M1 either correct expression A1 36 564.975 or exact equivalent A1 28037.15 or exact equivalent **SC** M1A1 A0 for awrt 36565 and awrt 28037	
(b)	M1 valid attempt at r with their $S_{cc} \neq 28732.1$ and their $S_{ct} \neq 83634$ A1 awrt 0.865	
(c)	B1ft only ft if $\lvert r\rvert<1$ For a correct comment in context. Must include words underlined (Allow use of c for cost and t for sales) and be compatible with their value in (b). Must have that as one increases/decreases the other increases/decreases. Allow other words eg goes up Do not accept t and c are similar.	
(d)	M1 correct numerical expression for b ft their $S_{ct} \neq 83634$ Implied by awrt 0.9758 or better M1 attempt at a with their value of b substituted. Implied by awrt 5.837 or better A1*cso answer given so both method marks must be awarded and no incorrect working seen. Either $b = 0.9758$ (or better) **or** $a = 5.837$ (or better) must be seen somewhere along with the correct equation in t and c (do not allow fractions).	
(e)	M1 for substituting $c = 90$ into $t =$ awrt $-5.84 +$ awrt $0.976c$ Implied by awrt 82 A1 £82 million (must include units. Allow 82 million pounds). Allow awrt £82 million	
(f)	M1 forming inequality (allow > or < or = or „ or …) with $0.8c$ A1 correct inequality in c (allow any letter) with awrt 33.2 (units not required). Do not allow as a fraction. Ignore any lower limit. Condone awrt 33200000 or awrt 33.2 million	

Question Number	Scheme	Marks
3. (a)	$[\bar{x} =]\dfrac{-1.2}{8}\ [=-0.15]$ $"-0.15" = \dfrac{\bar{b}-21}{2}$ oe $\sum b = 21\times 8 + 2\times(-1.2)\ [=165.6]$ $[\bar{b} =]\dfrac{165.6}{8}$ = **<u>20.7</u>** (cm)	M1 M1 A1 (3)
(b)	$\sigma_x = \sqrt{\dfrac{5.1}{8} - \left(\dfrac{-1.2}{8}\right)^2}\ [=\sqrt{0.615} = 0.784...]$ $\sigma_b = 2\times '0.784...'$ = awrt **<u>1.57</u>** (cm)	M1 M1 A1 (3)
(c)(i)	$x_9 = 1.2 \rightarrow b_9 = 1.2\times 2 + 21$ oe **or** $9\times 21 - 8\times '20.7'\ [=354.6]$ = **<u>23.4</u>** (cm)	M1 A1 (2)
(ii)	$\sum x^2 = 5.1 + 1.2^2\ [=6.54]$ $\left[\Rightarrow \sigma_x = \sqrt{\dfrac{5.1+1.2^2}{9} - 0^2}\right]$ = awrt **<u>0.852</u>** (cm)	M1 A1 (2)
	Notes	**Total 10**

(a) 1st M1 for correct expression for $\bar{x}$ ignore letter

2nd M1 Using equation. $"\bar{x}" = \dfrac{\bar{b}-21}{2}$ where $-1.2 < '\bar{x}' < 1.2$ Condone b rather than $\bar{b}$

A1 20.7 oe

1st M1 for correct expression for $\sum b$

2nd M1 use of $"\sum b" \div n$ where $'\sum b' > 18$

(b) 1st M1 correct method for σ_x **or** σ_x^2 **or** $5.1 = \dfrac{\sum b^2 - 42\times "168.6" + 8\times 441}{4}$ **or** $\sum b^2 = 3447.6$

2nd M1 for use of 2 × their σ_x (or 4 × their σ_x^2) (adding 21 is M0) **or**

$\dfrac{"3447.6"}{8} - \left(\dfrac{"165.6"}{8}\right)^2$ or $\sqrt{\dfrac{"3447.6"}{8} - \left(\dfrac{"165.6"}{8}\right)^2}$

A1 awrt 1.57 Allow $\dfrac{\sqrt{246}}{10}$ (allow s_b = awrt 1.68 or $\dfrac{4\sqrt{246}}{35}$ from an $n-1$ method)

(c)(i) M1 for a correct equation using $x_9 = 1.2$ to enable b_9 to be found eg $1.2 = \dfrac{b-21}{2}$

or a correct method to find $\sum x$ for the 9 squirrels. ft their 20.7

A1 23.4 oe

(ii) M1 for $5.1 + "(\pm 1.2)"^2\ [=6.54]$ seen ft their x_9 Condone $5.1 + (\pm 9.6)^2\ [=97.26]$

A1 awrt 0.852 Allow $\dfrac{\sqrt{654}}{30}$ (allow s_x = awrt 0.904 from an $n-1$ method)

Question Number	Scheme	Marks
4.	$[F(6) =]\frac{45}{77}$ **and** $[F(7) =]\frac{60}{77}$	M1
	$[P(W = 7) = F(7) - F(6) =]"\frac{60}{77}"-"\frac{45}{77}"\left[=\frac{15}{77}\right]$ **and**	
	$[P(W = 8) = F(8) - F(7) =]1-"\frac{60}{77}"\left[=\frac{17}{77}\right]$	M1
	$E(W) = 6\times"\frac{45}{77}"+7\times"\frac{15}{77}"+8\times"\frac{17}{77}"$	
	$[= 6\times 0.5844 + 7\times 0.1948 \ + \ 8\times 0.22077]$	M1
	$= \mathbf{\frac{73}{11}}$ **or awrt <u>6.64</u>**	A1
	Notes	**[4]**
	1st M1 for $\frac{45}{77}$ **and** $\frac{60}{77}$ seen Allow awrt 0.58 **and** awrt 0.78. may be seen unsimplified Implied by 2nd M1 or by seeing $\frac{15}{77}$ 2nd M1 for $"\frac{60}{77}"-"\frac{45}{77}"$ **and** $1-"\frac{60}{77}"$ allow awrt 0.195 or 0.20 **and** awrt 0.22 ft their F(6) and F(7) if working shown 3rd M1 for an attempt to calculate E(W) with P(W = 6) correct and the correct method or value for at least one of P(W = 7) or P(W = 8) A1 $\frac{73}{11}$ oe or awrt 6.64	

Question Number	Scheme	Marks
5. (a)	$P(W > 70) = P\left(Z > \frac{70-80}{8}[=-1.25]\right)$	M1
	$= P(Z > -1.25)$ or $P(Z < 1.25)$	A1
	$= 0.8944$ awrt **0.894**	A1
		(3)
(b)	$P(W < k) = 0.85$ or $P(W > k) = 0.15$	B1
	$\pm\left(\frac{k-80}{8}\right) = \mathbf{1.0364}$	M1 B1
	$k = 88.29\ldots$ awrt **88.3**	A1
		(4)
(c)	$P(W < 66) = P\left(Z < \frac{66-80}{8}[=-1.75]\right)[= 0.0401$ (calc 0.040059…)]	M1
	$0.25 \times P(Z < -1.75)[= 0.010025$ (calc 0.0100147...)] or $0.25 \times (1 - P(Z < 1.75))$	dM1
	$\frac{y-80}{8} = \mathbf{-2.32}(63)$	M1 A1
	$y = 61.389\ldots$ awrt **61.4**	A1
		(5)
	Notes	**Total 12**

(a)
M1 for standardising with 70, 80 and 8 (allow $\pm$)
1st A1 $z = \pm 1.25$
2nd A1 awrt 0.894 (calc 0.894350…) **NB** do not ISW so an answer of 0.1056 is A0

(b)
1st B1 for either correct probability statement. Allow „ for < and …for >
(may be implied by z = awrt 1.04)
M1 standardising with 80, 8 and equating to z, where $1 < |z| < 2$
2nd B1 $z = \pm 1.0364$ or better (calc 1.036432…)
A1 awrt 88.3 (calc 88.291459…)
NB awrt 88.3 implies 1st B1 and M1 but not the 2nd B1 they could get B1M1B0A1
(Answer only 88.291 to 88.292 scored 4 out of 4)

(c)
1st M1 standardising with 66, 80 and 8 (allow $\pm$) or seeing awrt 0.0401 in working
2nd dM1 (dep on 1st M1) $0.25 \times$"their $P(Z < -1.75)$" or 0.0401 – 0.030075 or seeing
$[0.75 \times 0.0401 + 0.9599 =]$ 0.9899…
3rd M1 for standardising and equating to z, where $|z| > 2$
1st A1 correct standardisation equation with compatible signs and 2.32 „ $|z|$ „ 2.34
2nd A1 awrt 61.4 (allow awrt 61.3)

Question Number	Scheme	Marks
6. (a)(i)	[P(A) =] **0.25**	B1
(ii)	[P($A \mid B$) =] **1**	B1
(iii)	[P($A \mid C$) =] **0**	B1
		(3)
(b)	$\frac{q}{q+r}=\frac{3}{5}$	M1
	$0.13+p+s=\frac{7}{10}$	M1
	$p+q+r+s+0.12+0.13=1$	M1
	Solving simultaneously to get	
	$\frac{q}{0.3-0.12}=\frac{3}{5}$ **or** $0.3=0.12+1.5r+r$ **or** $0.3=0.12+q+\frac{2}{3}q$ oe	dM1
	q = **0.108**	A1
	r = **0.072**	A1
		(6)
(c)	$\frac{5}{8}=0.13+0.12+'0.072'+s$ oe	M1
	s = **0.303**	A1
		(2)
	Notes	**Total 11**

(a)(i) B1 0.25 oe

(ii) B1 1 cao

(iii) B1 0 cao

(b) 1st M1 correct expression for $P(C \mid D)=\frac{3}{5}$. Allow P(D) for $q+r$

2nd M1 correct expression for $P(B' \cap D') = \frac{7}{10}$

3rd M1 A correct equation or use of sum of probabilities = 1 **must** imply correct equation eg may ft their

$P(B' \cap D') = \frac{7}{10}$ Implied by $q+r=0.18$

or P(D) = 0.18

NB $\frac{3}{10}=0.12+q+r$ is 2ndM1 3rdM1

4th dM1 (dep on all 3 previous M1 being awarded) solving to obtain a correct equation in a single variable. Implied by a correct value for q or r

1st A1 $q = 0.108$ or $\frac{27}{250}$ oe

2nd A1 $r = 0.072$ or $\frac{9}{125}$ oe

(c) M1 correct expression for $P(B \cup C') = \frac{5}{8}$ ft their value for r. Allow use of the letter r

eg $\frac{5}{8}=0.13+0.12+r+s$ oe We will condone values of r outside the range $0 < r < 1$

A1 $s = 0.303$ oe

Question Number	Scheme	Marks
7. (a)	$\left[\frac{0.1}{0.8}\right] = \underline{\mathbf{\frac{1}{8}}}$	B1 (1)
(b)	$[0^2 \times 0.1+] 5^2 \times 0.2 + 10^2 \times 0.7 = 75*$	B1*cso (1)
(c)	$\mathrm{E}(X) = [0 \times 0.1+] 5 \times 0.2 + 10 \times 0.7 [= 8]$ $\mathrm{Var}(X) = 75 - ('8')^2$ $\mathrm{Var}(X) = \underline{\mathbf{11}}$	M1 M1 A1 (3)
(d)	$\mathrm{Var}(4-3X) = 3^2 \times \mathrm{Var}(X) [= 3^2 \times "11"]$ $= \underline{\mathbf{99}}$	M1 A1ft (2)
(e)	P((0, 5), (0, 10), (5, 10)) $= 0.1 \times 0.2 + 0.1 \times 0.7 + 0.2 \times 0.7$ $[= 0.02 + 0.07 + 0.14]$ $= \underline{\mathbf{0.23}}$ P((0, 0), (5, 5), (10, 10) $= 1 - (0.1^2 + 0.2^2 + 0.7^2)$ $[= 0.5(1 - (0.01 + 0.04 + 0.49))]$ $= \underline{\mathbf{0.23}}$	M1M1 A1 (3)
(f)	Products: 0, 25, 50, 100 $\mathrm{P}(D=0) = 0.1 + 0.1 - 0.1 \times 0.1 [= 0.19]$ $\mathrm{P}(D=25) = 0.2^2$ $\mathrm{P}(D=50) = 2 \times 0.2 \times 0.7$ $\mathrm{P}(D=100) = 0.7^2$ D: **0**, **25**, **50**, **100** P($D=d$): **0.19**, **0.04**, **0.28**, **0.49**	B1 M1 M1 A1 (4)
	Notes	**Total 14**
(a)	B1 $\frac{1}{8}$ oe Allow 0.125 Do not ISW	
(b)	B1*cso correct expression and 75 with no errors seen. Allow $5^2 \times 0.2 + 10^2 \times 0.7 = 75$	
(c)	M1 correct method to find mean. If no method seen award if 8 is seen M1 attempt at expression for variance ie 75 –(their E(X))^2 A1 11 cao	
(d)	M1 Use of $(-3)^2 \times \mathrm{Var}(X)$ (condone 3 rather than –3 and missing bracket if final answer is correct) or $4^2 \times 0.1 + (-11)^2 \times 0.2 + (-26)^2 \times 0.7 - (-20)^2$ condone 11, 26 and 20 A1ft 99 or ft 9 × 'their (c)'	
(e)	1st M1 for at least one correct product. **NB** may be combined eg 0.3×0.7 but not in the numerator or denominator of a fraction 2nd M1 a fully correct expression oe e.g. $0.1 \times 0.2 + 0.3 \times 0.7$ A1 0.23 oe	
(f)	B1 all 4 correct products with no incorrect extras unless they have a probability of 0 associated with them 1st M1 A correct method to find 1 of the 4 probabilities. Does not need to be associated with the correct product **ALT** $\mathrm{P}(D=0) = 0.1 \times 0.1 + 2 \times 0.1 \times 0.2 + 2 \times 0.1 \times 0.7 [= 0.19]$ 2nd M1 A correct method to find 3 of the 4 probabilities or 2 of the 4 probabilities if the total of the 4 probabilities is 1 Must be associated with the correct product A1 all four correct probabilities (oe) associated with the correct products	