Question	Mark Scheme		Marks
1. (a)	$\sum m = 150$; $\sum m^2 = 5500$		
	$\sum t = 71.6$; $\sum t^2 = 930$; $\sum mt = 2147$	5500 & 2147 seen	B1
	$S_{mt} = 2147 - \frac{150 \times 71.6}{6} = \underline{357}$	Accept $\frac{357}{60} = 59.5$	M1 A1
	$S_{mm} = 5500 - \frac{150^2}{6} = \underline{1750}$ No working shown SR: B1 B1 only	Accept $291.\dot{6}$	A1 (4)
(b)	$b = \frac{357}{1750} = \underline{0.204}$		M1
	$a = \frac{71.6}{6} - 0.204 \times \frac{150}{6} = \underline{6.8\dot{3}}$		M1
	$\therefore \underline{t = 6.83 + 0.204m}$ No working seen SR: t = 6.83 + 0.204m B1 only	(Accept $6.8\dot{3}$, 6.83, $6\frac{5}{6}$%)	A1 (3)
(c)	$7.35 \Rightarrow m = 35$		
	$\therefore t = 6.8\dot{3} + 0.204 \times 35 = \underline{13.97\dot{3}}$	14.0 AWRT	M1 A1 (2)
(d) (i)	$9.00 \Rightarrow m = 120$		
	No; outside range of data (after 7.50 am)		B1; B1
(ii)	No; No evidence model will apply one month later		B1; B1 (4)

Question	Mark Scheme		Marks
2. (a)	Symmetrical (about the mean μ)		
	Mode = mean = median		
	Horizontal axis asymptotic to curve		B1;B1;B1 (3)
	Distribution is 'bell shaped' – accept sketch		Any 3 sensible properties
	95% of data lies within 2 sd's of the mean		
(b)	X ~ N $(27, 10^2)$		
	$\therefore$ P (26 < × < 28) = $P\left(\frac{26-27}{10} < Z < \frac{28-27}{10}\right)$	Standardising with $\mu = 27$, $\sigma = 10$ or $\sqrt{10}$ One correct (seen)	M1 A1
	$= P(-0.1 < Z < 0.1)$	-0.1 or 0.1	A1
	$= \Phi(0.1) - \{1 - \Phi(0.1)\}$ or $2 \times \{\Phi(0.1) - 0.5\}$		
	= <u>0.0796</u>	<u>0.0796 or 0.0797</u>	A1 (4)

Data is continuous	B0
Area under curve = 1	B0
Limits are $-\infty$ & ∞	B0
IQR contains 50% of data	B0
68% between $\mu \pm \sigma$	B1
Most of data within 3 s.d of mean	B1
No +ve or –ve skew	B1
Never touches axes at either side (ie asymptotic)	B1

Question	Mark Scheme		Mark	
3. (a)	$P(1 < X \le 3) = P(X = 2) + P(X = 3)$		M1	
	$= \frac{1}{12} + \frac{1}{12} = \frac{2}{12} = \frac{1}{6}$	$\frac{2}{12}$; $\frac{1}{6}$; 0.167; $0.16\dot{6}$; $0.1\dot{6}$	A1	(2)
(b)	$F(2.6) = P(X \le 2) = 1 - P(X = 3) = 1 - \frac{1}{12} = \frac{11}{12}$	$\frac{11}{12}$; 0.917; $0.91\dot{6}$	B1	(1)
	$(\text{or}: P(X \le 2) = \frac{1}{3} + \frac{1}{2} + \frac{1}{12} = \frac{11}{12})$			
(c)	$E(X) = \left(0 \times \frac{1}{3}\right) + \ldots + \left(3 \times \frac{1}{12}\right) = \frac{11}{12}$	Use of $\Sigma x P(X = x)$	M1	
		$\frac{11}{12}$; AWRT 0.917	A1	(2)
(d)	E (2X-3) = 2E(X)-3	Use of E (ax + b)	M1	
	$= 2 \times \frac{11}{12} - 3 = -\frac{14}{12} = -\frac{7}{6}$	$-\frac{7}{6}$; $-1\frac{1}{6}$; AWRT -1.17	A1	(2)
(e)	$\text{Var}(X) = 1^2 \times \frac{1}{2} + \ldots + 3^2 \times \frac{1}{12} - \left(\frac{11}{12}\right)^2$	Use of $E(X^2) - \{E(X)\}^2$	M1	
		Correct substitution	A1√	
	$= \frac{107}{144}$	$\frac{107}{144}$; AWRT 0.743	A1	(3)

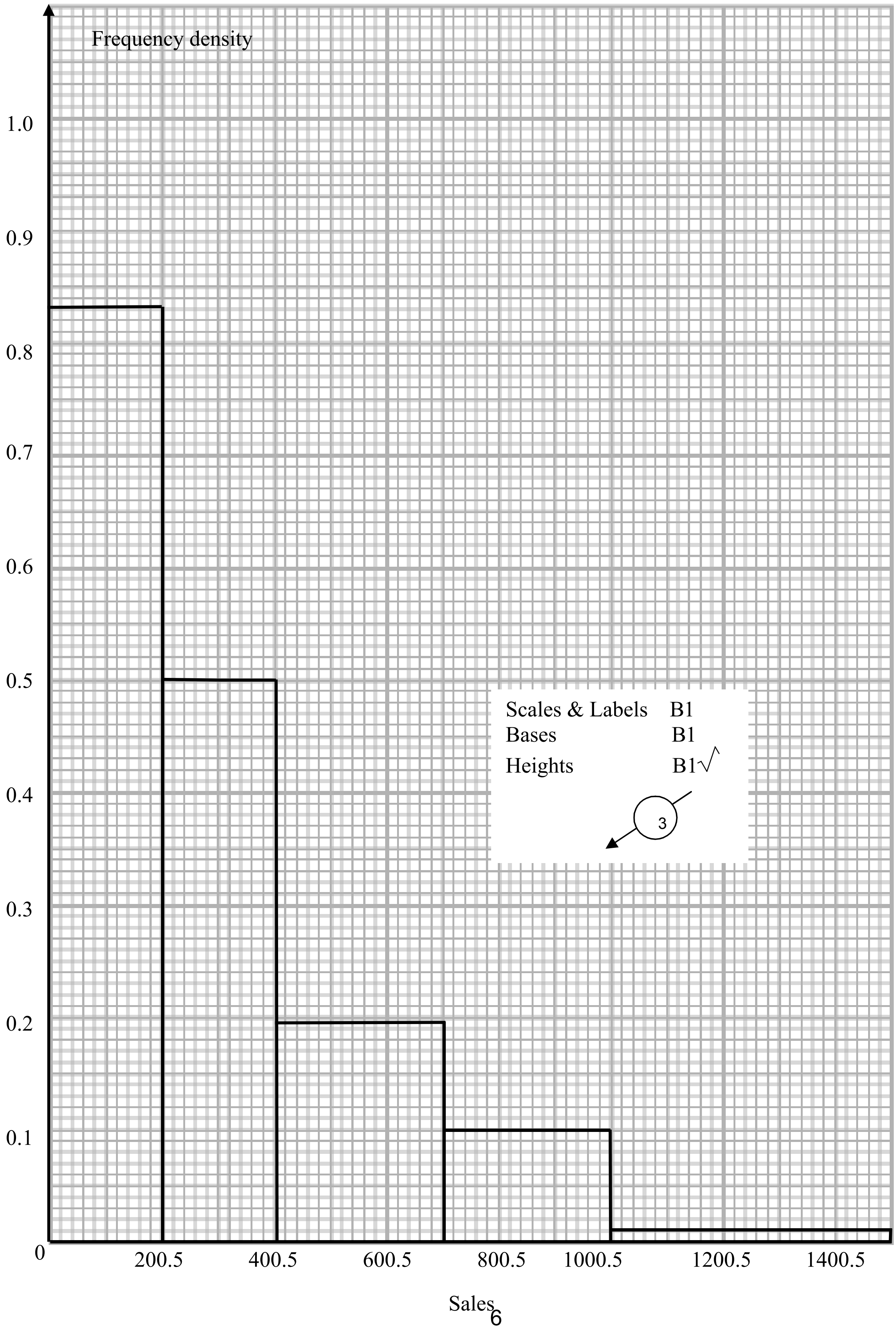
Question	Mark Scheme	Marks
4. (a) (i)	$P(A \cap B') = P(A/B')\,P(B') = \frac{4}{5} \times \frac{1}{2} = \frac{4}{10} = \underline{\frac{2}{5}}$ Use of $P(A/B')P(B')$	M1 A1
(ii)	$P(A \cap B) = P(A) - P(A \cap B')$	M1
	$= \frac{2}{5} - \frac{2}{5}$	
	$= \underline{0}$	A1
(iii)	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$	M1
	$= \frac{2}{5} + \frac{1}{2} - 0$	
	$= \underline{\frac{9}{10}}$	A1 ft
(iv)	$P(A/B) = P\frac{(A \cap B)}{P(B)} = 0$	B1 ft (7)
(b) (i)	since $P(A \cap B) = 0$ seen A and B are mutually exclusive	B1 B1 (2)
(ii)	Since $P(A/B) \neq P(A)$ or equivalent A and B are NOT independent	B1 B1 (2)

Question	Mark Scheme		Marks	
5. (a)	see table below	Frequency densities	M1 A1	
		Graph (3)		(5)

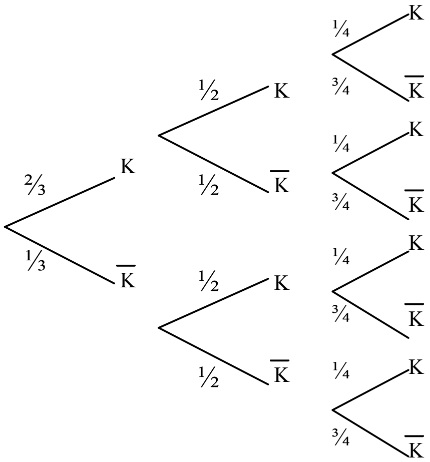
Sales	No. of days	Class width	Frequency density
1-200	166	200	0.830
201-400	100	200	0.500
401-700	59	300	0.197
701-1000	30	300	0.100
1001-1500	5	500	0.010

NB Frequency densities can be scored on graph

Question	Mark Scheme		Marks	
(b)	$Q_2 = 200.5 + \frac{(180-166)}{100} \times 200 = \underline{228.5}$	228/229/230	M1 A1	
	$Q_1 = 0.5 + \frac{90}{166} \times 200 = \underline{108.933}\cdots$	109 AWRT	A1	
	$Q_3 = 400.5 + \frac{(270-266)}{59} \times 300 = \underline{420.838}$	AWRT 421/425	A1	
	$(n = 270.75 \Rightarrow Q_3 = 424.6525)$			
	$\text{IQR} = 420.830\ldots - 108.933\ldots = \underline{311.905}\ldots$		$\sqrt{}$B1	(5)
(c)	$\sum fx = 110980 \;;\; \sum fx^2 = 58105890$	Attempt at Σfx or Σfy	M1	
	$\sum fy = 748 ; \sum fy^2 = 3943.5$ where $y = \frac{x - 100.5}{100}$	Attempt at Σfx^2 or Σfy^2	M1	
	$\mu = 308.277\dot{7}$	308 AWRT	M1 A1	
	$\sigma = 257.6238$	258 AWRT	M1 A1	(6)
	No working shown: SR B1 B1 only for μ, σ.			


Frequency density
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
200.5
400.5
600.5
800.5
1000.5
1200.5
1400.5
Sales
Scales & Labels B1
Bases B1
Heights B1√
3

Question	Mark Scheme	Marks
(d)	Median & IQR	B1
	Sensible reason e.g. Assuming other years are skewed.	B1 dep (2)

Question	Mark Scheme		Marks	
6. (a)		Tree with correct number of branches	M1	
		$\frac{2}{3},\frac{1}{3}$	A1	
		$\frac{1}{2},\frac{1}{2},\frac{1}{2},\frac{1}{2}$	A1	
		$\frac{1}{4},\frac{3}{4}\ldots\frac{3}{4}$	A1	(4)
(b)	P (All 3 Keys) $=\frac{2}{3}\times\frac{1}{2}\times\frac{1}{4}=\frac{2}{24}=\frac{1}{12}$	$\frac{1}{12}$; $0.08\dot{3}$; 0.0833	M1 A1	(2)
(c)	$\text{P(exactly 1 key)}=\left(\frac{2}{3}\times\frac{1}{2}\times\frac{3}{4}\right)+\left(\frac{1}{3}\times\frac{1}{2}\times\frac{3}{4}\right)+\left(\frac{1}{3}\times\frac{1}{2}\times\frac{1}{4}\right)$	3 triples added	M1	
	$=\underline{\frac{10}{24}=\frac{5}{12}}$	Each correct $\frac{10}{24}$; $\frac{5}{12}$; $0.41\dot{6}$; 0.417	A1 A1 A1 A1	(5)
(d)	P (Keys not collected on at least 2 successive stages)			
	$=\left(\frac{2}{3}\times\frac{1}{2}\times\frac{3}{4}\right)+\left(\frac{1}{3}\times\frac{1}{2}\times\frac{1}{4}\right)+\left(\frac{1}{3}\times\frac{1}{2}\times\frac{3}{4}\right)$	3 triples added	M1	
		Each correct	A1 A1 A1	
	$=\frac{10}{24}=\frac{5}{12}$	$\frac{10}{24}$; $\frac{5}{12}$; $0.41\dot{6}$; 0.417	A1	(5)

Question	Mark Scheme	Marks
6. (d)	**Alternative:**	
	1 – P (Keys collected on at least 2 successive stages)	M1
	$= 1 - \left\{\left(\frac{2}{3}\times\frac{1}{2}\times\frac{1}{4}\right)+\left(\frac{2}{3}\times\frac{1}{2}\times\frac{3}{4}\right)+\left(\frac{1}{3}\times\frac{1}{2}\times\frac{1}{4}\right)\right\}$	A1 A1 A1
	$= \frac{5}{8}$	A1 (5)