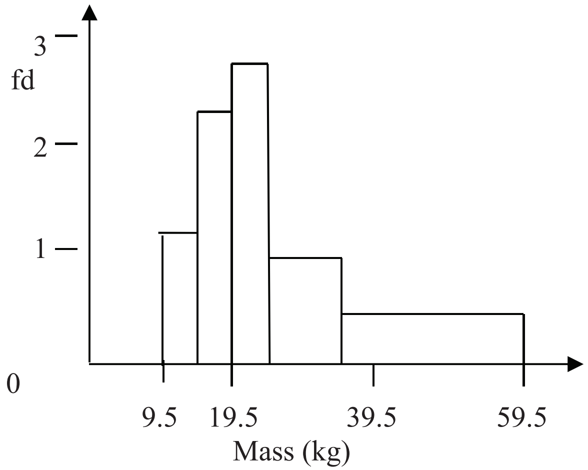
Question	Answer	Marks	Guidance
1(i)	15–19 (kg) cao	**B1**	kg not necessary; condone 14.5 – 19.5
	Total:	**1**	
1(ii)	fd = 1.2, 2.4, 2.8, 1, 0.32	**M1**	Attempt at fd [f/(attempt at cw)] or scaled freq (may be implied by 4 correct)
		**A1**	Correct heights seen on diagram with linear vertical scale from (x, 0)
		B1	Correct bar widths (1:1:1:2:5) visually no gaps with linear horizontal scale from (9.5,y) and first bar starting at (9.5, y)
		B1	Histogram, using attempted fds, with labels (mass, kg and fd seen) and at least 3 linearly spaced values on each axis. Horizontal axis must range from at least 9.5 to 59.5 If horizontal axis clearly starts from zero, either a break in the scale must be indicated or the scale must be linear from zero.

Question	Answer	Marks	Guidance
2(i)	$z = 0.674$	B1	z value ±0.674
	$0.674 = \frac{0 - -3}{\sigma}$	M1	±Standardising with 0 and equating to a z-value
	$\sigma = 4.45$	A1	Correct answer www ie not ignoring a minus sign
	Total:	3	
2(ii)	P(0, 1)	M1	Any bin of form ${}^8C_x(0.75)^x\,(0.25)^{8-x}$ any x
	$= (0.75)^8 + {}^8C_1(0.25)(0.75)^7$	M1	Correct unsimplified answer, may be implied by numerical values
	$0.1001 + 0.2670 = 0.367$	A1	Correct answer
	Method 2 $1 - P(8,7,6,5,4,3,2) = 1 - (0.25)^8 - {}^8C_1(0.75)(0.25)^7 - \ldots$	M1	Any bin of form ${}^8C_x(0.75)^x\,(0.25)^{8-x}$ any x
	$- {}^8C_2(0.75)^6\,(0.25)^2$	M1	Correct unsimplified answer
	$= 0.367$	A1	Correct answer
	Total:	3	

Question	Answer	Marks	Guidance
3(i)	$(1-x)$ and 0.45 (or 0.3)	**B1**	Seen, either on tree diagram or elsewhere
	Beginners: $0.7 \times x +$ '0.45' $\times$ '$(1-x)$' $= 0.5$ Or Advanced: '0.3' $\times x + 0.55 \times$ '$(1-x)$' $= 0.5$ Or $0.7 \times x +$ '0.45'$\times$ '$(1-x)$' = '0.3' $\times x + 0.55\times$ '$(1-x)$'	**M1**	One of the three correct probability equations
	$x = 0.2$ oe	**A1**	Correct answer
	Total:	**3**	
3(ii)	$P(M \mid A) = \dfrac{P(M \cap A)}{P(A)} = \dfrac{0.2 \times 0.3}{0.5}$	**M1**	'i' $\times$ 0.3 as num or denom of a fraction
		M1	0.5 (or (1 – 'i') $\times$ 0.55 + 'i' $\times$ 0.3 unsimplified) seen as denom of a fraction
	$= 0.12 \left(\dfrac{3}{25}\right)$	**A1**	Correct answer
	Total:	**3**	

Question	Answer	Marks	Guidance
4(i)	Mean = (30 × 1500 + 21 × 2400)/51	**M1**	Multiply by 30 and 21, summing and dividing total by 51 $\left(\frac{45000+50400}{51}\right)$
	= 1870 (1870.59)	**A1**	correct answer (to 3sf)
	Total:	**2**	
4(ii)	$230^2 = \frac{\Sigma x_F{}^2}{30} - 1500^2$ so $\Sigma x_F{}^2 = 69\,087\,000$	**M1**	One correct substitution into a correct variance formula
		A1	Correct $\Sigma x_F{}^2$ (rounding to 69 000 000 2sf)
	$160^2 = \frac{\Sigma x_L{}^2}{21} - 2400^2$ so $\Sigma x_L{}^2 = 121\,497\,600$	**A1**	Correct $\Sigma x_L{}^2$ (rounding to 121 000 000 3sf)
	New var = $\frac{69087000+121497600}{51} - 1870.588^2 = 237\,853$	**M1**	using '$\Sigma x_F{}^2$'+ '' $\Sigma x_L{}^2$ dividing by 51 and subtracting 'i' squared. (Correct '$\Sigma x_F{}^2$' + '' $\Sigma x_L{}^2$ = 190 584 600)
	New sd = 488	**A1**	Correct answer accept anything between 486 and 490
	Total:	**5**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td rowspan="6">5(i)</td><td rowspan="2">$P(0) = 0.6 \times 0.25 \times 0.5 = 0.075$
$P(1) = 0.4 \times 0.25 \times 0.5 + 0.6 \times 0.75 \times 0.5 + 0.6 \times 0.25 \times 0.5 = 0.35$
$P(2) = 0.4 \times 0.75 \times 0.5 + 0.4 \times 0.25 \times 0.5 + 0.6 \times 0.75 \times 0.5 = 0.425$
$P(3) = 0.4 \times 0.75 \times 0.5 = 0.15$</td><td>B1</td><td>0, 1, 2, 3 seen as top line of a pdf table OR attempting to evaluate P(0), P(1), P(2) and P(3)</td></tr>
<tr><td>M1</td><td>Multiply 3 probabilities together from 0.4 or 0.6, 0.25 or 0.75, 0.5 with or without a table</td></tr>
<tr><td rowspan="3"><table><tr><td>No of heads</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Prob</td><td>0.075 $\left(\frac{3}{40}\right)$</td><td>0.35 $\left(\frac{7}{20}\right)$</td><td>0.425 $\left(\frac{17}{40}\right)$</td><td>0.15 $\left(\frac{3}{20}\right)$</td></tr></table></td><td>M1</td><td>Summing 3 probabilities for P(1) or P(2) with or without a table</td></tr>
<tr><td>B1</td><td>One correct probability seen.</td></tr>
<tr><td>A1</td><td>All correct in a table</td></tr>
<tr><td>Total:</td><td>5</td><td></td></tr>
<tr><td>5(ii)</td><td>$E(X) = 0.35 + 2 \times 0.425 + 3 \times 0.15 = 1.65 \left(\frac{33}{20} \text{ oe}\right)$</td><td>M1</td><td>Correct unsimplified expression for the mean using their table, $\sum p = 1$; can be implied by correct answer</td></tr>
<tr><td rowspan="3">5(ii)</td><td>$Var(X) = 0.35 + 4 \times 0.425 + 9 \times 0.15 – 1.65^2$</td><td>M1</td><td>Correct unsimplified expression for the variance using their table and their mean^2 subtracted, $\sum p = 1$</td></tr>
<tr><td>$= 0.678\ (0.6775) \left(\frac{271}{400} \text{ oe}\right)$</td><td>A1</td><td>Correct answer</td></tr>
<tr><td>Total:</td><td>3</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
6(i)	$z_1 = \pm\frac{4.1-5.7}{0.8} = -2$ $\quad z_2 = \pm\frac{5-5.7}{0.8} = -0.875$	M1	At least one standardising no cc no sq rt no sq using 5.7 and 0.8 and either 4.1 or 5
	P(Toffee Apple) $= P(d < 5.0) - P(d < 4.1)$ $= P(z < -0.875) - P(z < -2)$ $= \Phi(-0.875) - \Phi(-2)$ $= \Phi(2) - \Phi(0.875)$	M1	Correct area $\Phi - \Phi$ legitimately obtained – need 2 negative z-values or 2 positives – not one of each
	$= 0.9772 - 0.8092 = 0.168$ (or $0.1908 - 0.0228$)	A1	Correct final answer
	Total:	**3**	
6(ii)	$np = 250 \times 0.168 = 42$, $\quad npq = 34.944$	B1ft	Correct unsimplified mean and var – ft their prob for **(i)** providing $(0 < p < 1)$ Implied by $\sigma = \sqrt{34.944} = 5.911$
	$P(< 50) = P\left(z < \frac{49.5-42}{\sqrt{34.944}}\right) = P(z < 1.2687)$	M1	± Standardising using 50, their mean and sd; must have sq rt.
		M1	49.5 or 50.5 seen as a cc
	$= \Phi(1.2687)$	M1	Correct area Φ(> 0.5 for + z and < 0.5 for –z)in their final answer
	$= 0.898$	A1	Correct final answer
	Total:	**5**	

Question	Answer	Marks	Guidance
7(i)	****E**** Other letters arranged in $\frac{8!}{2!3!}$	M1	Mult by 8! or $^8P_8$ oe (arrangements ignoring repeats)
	= 3360 ways	A1	Correct final answer www
	OR $\frac{8\times7\times6\times5\times4\times4\times3\times2\times1}{4!2!}$ = 3360 ways	M1	Correct numerator (161 280)
		A1	Correct final answer www
	Total:	**2**	
7(ii)	* * * * * ↑ Arrangements other letters × ways Es inserted	M1	k mult by $^6C_4$ or $^6P_4$ oe (ways to insert Es ignoring repeats), k can = 1 or k mult by $\frac{5!}{2!}$
	$= \frac{5!}{2!} \times {}^6C_4 \left(\frac{5!}{2!}\times\frac{^6P_4}{4!}\right)$	M1	Correct unsimplified expression or $\frac{5!}{2!}\times{}^6P_4$
	= 900 ways	A1	Correct answer
	OR Total no of ways – no of ways with Es touching 9!/(4! × 2!) – … or 7 560 – …	M1	7560 unsimplified – k
	$\frac{6!}{2!} + {}^6P_2\times\frac{5!}{2!} + \frac{^6P_2}{2!}\times\frac{5!}{2!} + \frac{^6P_3}{2!\times\frac{5!}{2!}}$ = 360 + 1800 + 900 + 3600 = 6660	M1	Attempting to find four ways of Es touching (4 Es, 3Es and a single, 2 lots of 2 Es, 2 Es and 2 singles)
	7 560 – 6 660 = 900	A1	Correct answer

Question	Answer	Marks	Guidance
7(ii)	OR Adding the number of ways with the first E in the 1st (E_1), 2nd (E_2) or 3rd (E_3) position. $\frac{5!}{2!}$ $(E_1 + E_2 + E_3)$ where $E_1 = 10$, $E_2 = 4$, $E_3 = 1$	M1	For any values for E_1, E_2 and E_3
	$\frac{5!}{2!}$ $(E_1 + E_2 + E_3)$	M1	For any two correct values of E_1, E_2 and E_3
	600 + 240 + 60 = 900	A1	Correct answer
	Total:	**3**	
7(iii)	EENN* in 3 ways	B1	Numerical value must be stated
	Total:	**1**	

Question	Answer	Marks	Guidance
7(iv)	EE *** with no N: 1 way EEN** 3C2 or listing 3 ways EENN* 3 ways from **(iii)**	**M1**	Identifying the three different scenarios of EE, EEE or EEEE
		A1	Total no of ways with two Es (7 or 3 + 3 + 1)
	EEE** with no N: 3 ways EEEN* 3 ways EEENN 1 way	**A1**	Total no. of ways with 3 Es (7)
	EEEE* no N 3 ways EEEEN 1 way Total 18 ways	**A1**	Correct answer stated
	Method List containing ways with 2Es, 3Es and 4Es List containing at least 8 correct different ways List of all 18 correct ways Total 18	**M1**	At least 1 option listed for each of EE^^^, EEE^^, EEEE^
		A1	Ignore repeated options
		A1	Ignore repeated/incorrect options
		A1	Correct answer stated
	Total:	**4**	