1 (i)	Mean = $\frac{180.6}{12}$ = 15.05 or 15.1	B1 for mean		
	$S_{xx} = 3107.56 - \frac{180.6^2}{1000}$ or $3107.56 - 12$ (their 15.05) ² =	M1 for attempt at S_{xx}		
	(389.53)		3	
	$s = \sqrt{\frac{389.53}{11}} = 5.95$ or better NB Accept answers seen without working (from calculator)	A1 cao		
(ii)	$\overline{x} + 2s = 15.05 + 2 \times 5.95 = 26.95$ $\overline{x} - 2s = 15.05 - 2 \times 5.95 = 2.15$	M1 for attempt at either M1 for both		
	So no outliers	A1 for limits and conclusion FT their mean and sd	3	
(iii)	New mean = $1.8 \times 15.05 + 32 = 59.1$	B1FT		
	New $s = 1.8 \times 5.95 = 10.7$	M1 A1FT	3	
(IV)	New York has a higher mean or is on average higher (oe)	ETFT using 'F (x dep)		
	New York has greater spread /range /variation or SD (oe)	E1FT using ${}^{0}F$ (σ dep)	2	
(V)	Upper bound (70) 100 110 120 150 170 190 Cumulative frequency (0) 6 14 2 45 4	B1 for all correct cumulative frequencies (may be implied from graph). <u>Ignore cf of 0</u> <u>at this stage</u>		
(vi)	$\left[\begin{array}{c} \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $	G1 for linear scales (linear from 70 to 190) ignore x < 70 vertical: 0 to 50 but not beyond 100 (no inequality scales) G1 for labels G1 for points plotted as (UCB, their cf). Ignore	5	
	NB all G marks dep on attempt at cumulative frequencies.	(70,0) at this stage. No mid – point or LCB plots. G1 for joining all of 'their points'(line or smooth curve) AND now		
	NB All G marks dep on attempt at cumulative frequencies Line on graph at cf = 43.2(soi) or used 90th percentile = 166	including (70,0) M1 for use of 43.2 A1FT but dep on 3rd G mark earned	2	
		TOTAL	18	

PhysicsAndMathsTutor.com

2 (i)	Mean = $\frac{3026}{56} = 54.0$	B1 for mean	
	$S_{xx} = 178890 - \frac{3026^2}{56} = 15378$	M1 for attempt at S_{xx}	
	$s = \sqrt{\frac{15378}{55}} = 16.7$	A1 CAO	3
(ii)	$\overline{x} + 2s = 54.0 + 2 \times 16.7 = 87.4$	M1 for their \overline{x} +2×their s	
	So 93 is an outlier	A1 FT for 87.4 and	2
		comment	
(iii)	New mean = $1.2 \times 54.0 - 10 = 54.8$	B1 FT	
	New $s = 1.2 \times 16.7 = 20.1$	M1A1 FT	3
		TOTAL	8

3 (i)	Either P(all 4 correct) = $\frac{4}{7} \times \frac{3}{6} \times \frac{2}{5} \times \frac{1}{4} = \frac{1}{35}$ or P(all 4 correct) = $\frac{1}{{}^{7}C_{4}} = \frac{1}{35}$	M1 for fractions, or ⁷ C ₄ seen A1 NB answer given	2
(ii)	$E(X) = 1 \times \frac{4}{35} + 2 \times \frac{18}{35} + 3 \times \frac{12}{35} + 4 \times \frac{1}{35} = \frac{80}{35} = 2\frac{2}{7} = 2.29$ $E(X^{2}) = 1 \times \frac{4}{35} + 4 \times \frac{18}{35} + 9 \times \frac{12}{35} + 16 \times \frac{1}{35} = \frac{200}{35} = 5.714$ $Var(X) = \frac{200}{35} - \left(\frac{80}{35}\right)^{2} = \frac{24}{49} = 0.490 \text{ (to 3 s.f.)}$	M1 for Σrp (at least 3 terms correct) A1 CAO M1 for $\Sigma x^2 p$ (at least 3 terms correct) M1 <i>dep</i> for – their E(X) ² A1 FT their E(X) provided Var(X) > 0	5
		TOTAL	7

4	r	1	2						B1 for 3 <i>k</i> , 5 <i>k</i> , 7 <i>k</i> , 9 <i>k</i>			
(i)	P(X = r)	k	3 <i>k</i>	5 <i>k</i>	7 <i>k</i>	9 <i>k</i>	11 <i>k</i>		M1 for sum of six multiples of $k = 1$			
			36		FRACTION IN SIMPLEST FORM)						
(ii)	$E(X) = 1 \times \frac{1}{36} + 2 \times \frac{3}{36} + 3 \times \frac{5}{36} + 4 \times \frac{7}{36} + 5 \times \frac{9}{36} + 6 \times \frac{11}{36} = \frac{161}{36} = 4.47$								M1 for Σ <i>rp</i> A1 CAO	2		
(iii)	$P(X=16) = 6 \times \left(\frac{1}{6}\right)^3$								M1 for 6 × M1 indep for $\left(\frac{1}{6}\right)^3$			
			=	A1 CAO	3							
									TOTAL	8		

5 (i)	P(X = 1) = 7k, $P(X = 2) = 12k$, $P(X = 3) = 15k$, $P(X = 4) = 16k50k = 1$ so $k = 1/50$	M1 for addition of four multiples of <i>k</i> A1 ANSWER GIVEN	2
(ii)	$E(X) = 1 \times 7k + 2 \times 12k + 3 \times 15k + 4 \times 16k = 140k = 2.8$ OR $E(X) = 1 \times \frac{7}{50} + 2 \times \frac{12}{50} + 3 \times \frac{15}{50} + 4 \times \frac{16}{50} = \frac{140}{50} = 2.8$	M1 for Σxp (at least 3 terms correct) A1 CAO	
	2.8 oe $Var(X) = 1 \times 7k + 4 \times 12k + 9 \times 15k + 16 \times 16k - 7.84 = 1.08$ OR Var(X) = 1 × ⁷ / ₅₀ + 4 × ¹² / ₅₀ + 9 × ¹⁵ / ₅₀ + 16 × ¹⁶ / ₅₀ - 7.84 = 8.92 - 7.84 = 1.08	M1 $\Sigma x^2 p$ (at least 3 terms correct) M1 <i>dep</i> for – their E(X) ² NB provided Var(X) > A1 FT their E(X)	5
		TOTAL	7