

1 (i)	Impossible because if 3 letters are correct, the fourth must be also.	E1	1
(ii)	There is only one way to place letters correctly. There are $4! = 24$ ways to arrange 4 letters. OR: $\frac{1}{4} \times \frac{1}{3} \times \frac{1}{2}$ NOTE: ANSWER GIVEN	E1 E1 B1 for $\frac{1}{4} \times \frac{1}{3}$ B1 for $\times \frac{1}{2}$	2
(iii)	$E(X) = 1 \times \frac{1}{3} + 2 \times \frac{1}{4} + 4 \times \frac{1}{24} = 1$ $E(X^2) = 1 \times \frac{1}{3} + 4 \times \frac{1}{4} + 16 \times \frac{1}{24} = 2$ So $\text{Var}(X) = 2 - 1^2 = 1$	M1 For $\sum xp$ (at least 2 non-zero terms correct) A1 CAO M1 for $\sum x^2 p$ (at least 2 non-zero terms correct) M1dep for – their $E(X)^2$ A1 FT their $E(X)$ provided $\text{Var}(X) > 0$	5
		TOTAL	8

2 (i)	The company could increase the mean weight. The company could decrease the standard deviation.	B1 CAO B1	2
(ii)	Sample mean = $11409/25 = 456.36$ $S_{xx} = 5206937 - \frac{11409^2}{25} = 325.76$ Sample s.d = $\sqrt{\frac{325.76}{24}} = 3.68$	B1 M1 for S_{xx} A1	3
		TOTAL	5

3			
(i)	$P(X = 4) = \frac{1}{40} (4)(5) = \frac{1}{2}$ (Answer given)	B1	Calculation must be seen
(ii)	$E(X) = (2+12+36+80)\frac{1}{40}$ So $E(X) = 3.25$	M1 A1 cao	Sum of rp
	$Var(X) = (2+24+108+320)\frac{1}{40} - 3.2$ $= 11.35 - 10.5625$ $= 0.7875$	M1 M1 dep A1 cao	Sum of r ² p -3.25
(iii)	Expected number of weeks = $\frac{6}{40} \times 45$ $= 6.75$ weeks	M1 A1	Use of np

4			
(i)	Mean = $83.95/8 = 10.49$	B1	
	Variance = $\frac{881.2119 - \frac{83.95^2}{8}}{7}$ $= 0.03737$	M1	
	Standard deviation = 0.193	A1	
(ii)	2 standard deviations below mean $= 10.49 - 2(0.193)$ $= 10.104$ but $10.04 < 10.104$ so 10.04 is an outlier.	M1 A1	Follow through if divisor n has been used above.
(iii)	This time is much faster than the others. This may be the result of wind assistance, faulty timing, false start and should be discarded. Opposite conclusion such as this could be a genuinely fast time, can also receive full credit.	E1 E1	Appreciating need for investigation Comment in context

5		r	0	1	2	3	4		
(i)		$P(X=r)$	$6k$	$10k$	$12k$	$12k$	$10k$		B1 B1 M1
									1 value correct all 3 correct sum of 1
(ii)		$E(X) = 110k = 2.2$							M1 A1
									sum of rp cao
(iii)		$P(X > 2.2) = 22k = 0.44$							B1

Question		Answer	Marks	Guidance	
6	(ii)	<p>Mean =</p> $\frac{(40 \times 11) + (55 \times 10) + (65 \times 18) + (75 \times 14) + (85 \times 7)}{60} = \frac{3805}{60}$ <p>= 63.4 (or 63.42)</p> $\Sigma x^2 f = (40^2 \times 11) + (55^2 \times 10) + (65^2 \times 18) + (75^2 \times 14) + (85^2 \times 7)$ $= 253225$ $S_{xx} = 253225 - \frac{3805^2}{60} = 11924.6$ $s = \sqrt{\frac{11924.6}{59}} = \sqrt{202.11} = 14.2$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>[4]</p>	<p>For midpoints Products are 440, 550, 1170, 1050, 595</p> <p>CAO (exact answer 63.41666...)</p> <p>For attempt at S_{xx} Should include sum of at least 3 correct multiples $fx^2 - \Sigma x^2/n$</p> <p>At least 1dp required Use of mean 63.4 leading to answer of 14.29199.. with $S_{xx} = 12051.4$ gets full credit.</p> <p>63.42 leads to 14.2014... Do not FT their incorrect mean (exact answer 14.2166...)</p>	<p>For midpoints (at least 3 correct) No marks for mean or sd unless using midpoints</p> <p>Answer must NOT be left as improper fraction as this is an estimate Accept correct answers for mean and sd from calculator even if eg wrong S_{xx} given</p> <p>Allow M1 for anything which rounds to 11900</p> <p>Allow SC1 for RMSD 14.1 (14.0976...) from calculator.</p> <p>Only penalise once in part (ii) for over specification, even if mean and standard deviation both over specified.</p> <p>If using $(x - \bar{x})^2$ method, B2 if 14.2 or better (14.3 if use of 63.4), otherwise B0</p>

Question		Answer	Marks	Guidance
6	(iii)	$\bar{x} - 2s = 63.4 - (2 \times 14.2) = 35$ $\bar{x} + 2s = 63.4 + (2 \times 14.2) = 91.8$ <p>So there are probably some outliers at the lower end, but none at the upper end</p>	<p>M1</p> <p>A1</p> <p>E1</p> <p>[3]</p>	<p>For either</p> <p>No marks in (iii) unless using $\bar{x} + 2s$ or $x - 2s$</p> <p>For both (FT)</p> <p>Must include an element of doubt and must mention both ends</p> <p>Only follow through numerical values, not variables such as s, so if a candidate does not find s but then writes here 'limit is $63.4 + 2 \times$ standard deviation', do NOT award M1</p> <p>Do not penalise for over-specification</p> <p>Must have correct limits to get this mark</p>
6	(iv)	$\text{Mean} = \frac{3624.5}{50} = 72.5\text{g (or exact answer 72.49g)}$ $S_{xx} = 265416 - \frac{3624.5^2}{50} = 2676$ $s = \sqrt{\frac{2676}{49}} = \sqrt{54.61} = 7.39\text{g}$	<p>B1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>CAO Ignore units</p> <p>For S_{xx}</p> <p>CAO ignore units Allow 7.4 but NOT 7.3 (unless RMSD with working)</p> <p>M1 for $265416 - 50 \times$ their mean^2 BUT NOTE M0 if their $S_{xx} < 0$</p> <p>For s^2 of 54.6 (or better) allow M1A0 with or without working.</p> <p>For RMSD of 7.3 (or better) allow M1A0 provided working seen</p> <p>For RMSD² of 53.5 (or better) allow M1A0 provided working seen</p>

Question		Answer	Marks	Guidance
6	(v)	<p>Variety A have lower average than Variety B oe</p> <p>Variety A have higher variation than Variety B oe</p>	<p>E1</p> <p>E1</p> <p>[2]</p>	<p>FT their means Do not condone lower central tendency or lower mean</p> <p>FT their sd</p> <p>Allow 'on the whole' or similar in place of 'average'. Allow 'more spread' or similar but not 'higher range' or 'higher variance' Condone less consistent.</p>

<p>7 (i)</p>	<p>(With $\sum fx = 7500$ and $\sum f = 10000$ then arriving at the mean)</p> <p>(i) £0.75 scores (B1, B1) (ii) 75p scores (B1, B1) (iii) 0.75p scores (B1, B0) (incorrect units) (iv) £75 scores (B1, B0) (incorrect units)</p> <p>After B0, B0 then sight of $\frac{7500}{10000}$ scores SC1. SC1 or an answer in the range £0.74 - £0.76 or 74p – 76p (both inclusive) scores SC1 (units essential to gain this mark)</p> <p><u>Standard Deviation: (CARE NEEDED here with close proximity of answers)</u></p> <ul style="list-style-type: none"> • 50.2(0) using divisor 9999 scores B2 (50.20148921) • 50.198 (= 50.2) using divisor 10000 scores B1 (<i>rmsd</i>) • If divisor is <u>not</u> shown (or calc used) and only an answer of 50.2 (i.e. <u>not</u> coming from 50.198) is seen then award B2 on b.o.d. (default) <p>After B0 scored then an attempt at S_{xx} as evident by either</p> $S_{xx} = (5000 + 200000 + 25000000) - \frac{7500^2}{10000} (= 25199375)$ <p style="text-align: center;">or</p> $S_{xx} = (5000 + 200000 + 25000000) - 10000(0.75)^2$ <p style="text-align: center;">scores (M1) or M1ft ‘their 7500²’ or ‘their 0.75²’</p> <p>NB The <u>structure</u> must be correct in both above cases with a max of <u>1 slip only after applying the f.t.</u></p>	<p>B1 for numerical mean (0.75 or 75 seen) B1dep for correct units attached</p> <p>B2 correct s.d. (B1) correct rmsd</p> <p>(B2) default</p> <p>$\sum fx^2 = 25,205,000$ Beware $\sum x^2 = 25,010,100$</p> <p>After B0 scored then (M1) or M1f.t. for attempt at S_{xx}</p> <p><i>NB full marks for correct results from recommended method which is use of calculator functions</i></p>	<p style="text-align: center;">4</p>
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(ii)	<p>P(Two £10 or two £100)</p> $= \frac{50}{10000} \times \frac{49}{9999} + \frac{20}{10000} \times \frac{19}{9999}$ $= 0.0000245 + 0.0000038 = (0.00002450245 + 0.00000380038)$ $= 0.000028(3) \text{ o.e.} = (0.00002830283)$ <p><u>After M0, M0</u> then $\frac{50}{10000} \times \frac{50}{10000} + \frac{20}{10000} \times \frac{20}{10000}$ o.e.</p> <p>Scores SC1 (ignore final answer but SC1 may be implied by sight of 2.9×10^{-5} o.e.)</p> <p>Similarly, $\frac{50}{10000} \times \frac{49}{10000} + \frac{20}{10000} \times \frac{19}{10000}$ scores SC1</p>	<p>M1 for either correct product seen (ignore any multipliers)</p> <p>M1 sum of both correct (ignore any multipliers)</p> <p>A1 CAO (as opposite with no rounding)</p> <p>(SC1 case #1)</p> <p>(SC1 case #2) <u>CARE</u> answer is also 2.83×10^{-5}</p>	<p>3</p>
		TOTAL	<p>7</p>