Question	Scheme	Marks	AOs
6. (a)	(mean $=\overline{x}=$) $\dfrac{1}{n}\sum_{r=1}^{n}(7+3r)$	M1	1.1a
	$\sum_{r=1}^{n}(7+3r)=\left(7\sum_{r=1}^{n}1+3\sum_{r=1}^{n}r=\right)7n+3\dfrac{n}{2}(n+1)$	M1	1.1b
	$\overline{x}=7+\dfrac{3}{2}(n+1)=\dfrac{14+3n+3}{2}=\dfrac{1}{2}(3n+17)$ *	A1*	2.1
		(3)	
(b)	Correct overall strategy to find the variance or standard deviation. This must include: • An attempt to find the mean • An attempt at $\sum(7+3r)^2$ as part of their formula (however poor, or if stated and followed by a value or if used with incorrect limits). • An attempt at either variance formula with their mean (allow slips in the formula)	M1	3.1a
(Mean)	mean $(=\overline{x})=136$	B1	1.1b
(Sum)	Way1: $\sum_{r=1}^{n}(7+3r)^2=\sum_{r=1}^{n}(49+42r+9r^2)$ $=\underline{\underline{49n}}+\underline{42\times\dfrac{1}{2}n(n+1)}+\underline{9\times\dfrac{1}{6}n(n+1)(2n+1)}$ Way 2: $\sum_{r=1}^{n}\left(x_i-\overline{x}\right)^2=\sum_{r=1}^{n}\left(7+3r-"136"\right)^2=a\sum_{r=1}^{n}r^2+b\sum_{r=1}^{n}r+c\sum_{r=1}^{n}1$ $=\underline{9\times\dfrac{1}{6}n(n+1)(2n+1)}-"774"\times\underline{\dfrac{1}{2}n(n+1)}+\underline{\underline{"16641"n}}$	$\underline{\text{M1}}$ $\underline{\underline{\text{B1}}}$	1.1b 1.1b
(Variance/standard deviation)	Way 1: $=\dfrac{"2032690"}{85}-136^2=\ldots$ or $\dfrac{"2032690"}{84}-\dfrac{85}{84}\times136^2=\ldots$ Way 2: $=\dfrac{"460530"}{85}=\ldots$ or $\dfrac{"460530"}{84}=\ldots$ (using sample standard deviation).	M1	1.1b
	So s.d = $\sqrt{5418}=73.6$ (g) Accept 74.0 (g) if sample s.d. used	A1	1.1b
		(6)	
	(9 marks)		

Notes		
(a)	**M1**	Selects the correct procedure for finding the mean ($\overline{x}$), attempting sum and dividing by *n*.
	M1	Splits the sum and applies the formulae for $\sum r$ (accept $7+3\frac{n}{2}(n+1)$ here) Or uses arithmetic series formula $\frac{1}{2}n(a+l)$ with a = 10 and l an attempt at 7 + 3×*n*, or $\frac{n}{2}(2a+(n-1)d)$ with a = 10 and d = 3..
	A1*	Correct work proceeding to the answer with an intermediate step shown. **Special case:** Award M0M1A0 for candidates who use $\frac{1}{2}(a+l)$ or equivalent without justification of the division by *n*.
(b)	**M1**	Correct overall strategy to get as far as the variance of marbles in the collection. The attempt at variance should be recognisable (though allow e.g sign slips in the formula for this mark) and an attempt, however poor, at $\sum(7+3r)^2$ must have been made
	B1	Correct value for the mean for 85 marbles (accept as a single fraction, $\frac{272}{2}$). If a student works algebraically until the last step, a correct final answer will imply this mark.
	M1	Expands brackets and applies summation formulae for $\sum_{r=1}^{n} r$ and $\sum_{r=1}^{n} r^2$ to their expression, either in terms of *n* or with *n* = 85 **but must have correct limits**. Allow for obtaining an expression of the correct form for Way 2 if the mean is kept in terms of "*n*". This mark is for correct application of these two summation formula on an attempt at $\sum_{r=1}^{n}(7+3r)^2$ so accept even if this is not part of an attempt at the variance.
	B1	Correct use of $\sum_{r=1}^{n} 1 = n$ in their expression (must be correct limits).
	M1	**Correctly applies** variance or standard deviation formula with *n* = 85, their attempt at $\sum x^2$ (which need not be using 7 + 3*r* or correct limits) and their mean. Accept use of the sample variance/standard deviation is used (dividing by $n-1$) For reference the variance formula is $\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i-\overline{x})^2 = \left(\frac{1}{n}\sum_{i=1}^{n}x_i^2\right)-\overline{x}^2$ where $x_r = 7+3r$ here, or accept for sample variance $\sigma^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i-\overline{x})^2 = \left(\frac{1}{n-1}\sum_{i=1}^{n}x_i^2\right)-\frac{n\overline{x}^2}{n-1}$
	A1	Correct standard deviation to 1 decimal place. If sample standard deviation is used, the answer will be 74.0 g to 1 d.p. (74.04…)
	Note: Question specifies use of summation formula and so these must be seen for the 2nd M and 2nd B mark. However, if just 2032690 appears from a calculator all other marks are available.	