

# How long is a 200 mm paver?

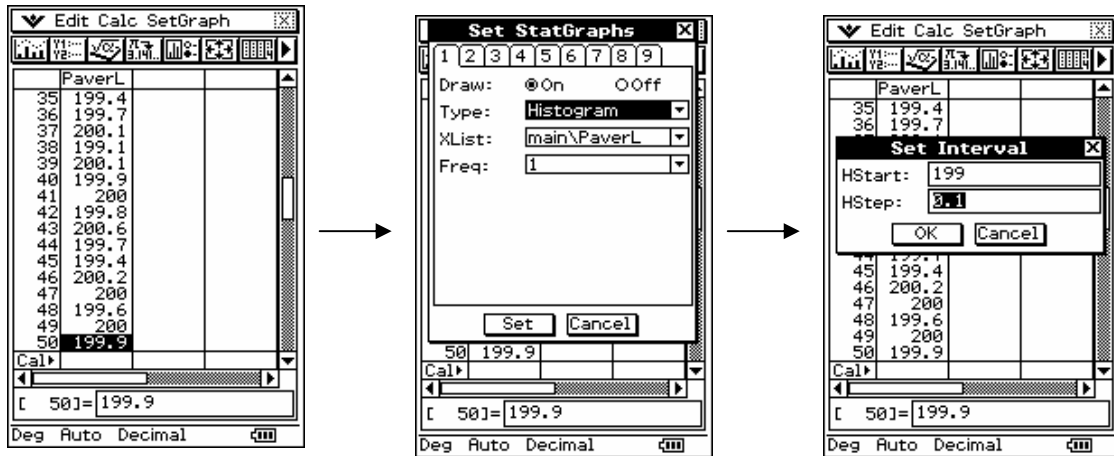
## Checkpoints

Activity 1 – Representing the lengths of a sample of pavers.

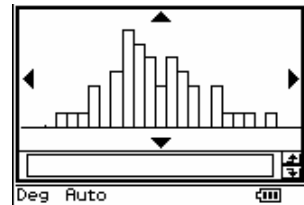


Answers.

1. Enter your data set, check your graph settings and draw...

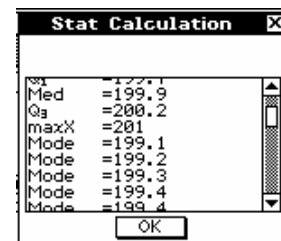
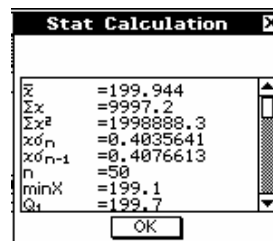


2. The histogram of these paver lengths is approximately bell shaped. Most of the lengths are close to the centre of the distribution, but a few lie 'further out', differing more from the 'average' length.



The histogram is roughly symmetrical in shape.

3. Using the one-variable calculation it can be seen that the mean paver length is 199.9 mm, as is the median length. The standard deviation of this sample of 50 pavers is 0.404 mm.



4. Based on this information, we can say that these 200 mm pavers are *close* to 200 mm in length. They all are within 1 mm of 200 mm, and half of them are between 199.7 mm and 200.2 mm

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## Checkpoints



**Activity 2 – Making pavers without getting your hands dirty.**



*Part B – Setting up the spreadsheet*

Enter the text in cells A1 and C1 and the given values in B1 and D1.

	A	B	C	D
1	Aim	200	Error	0.5
2				
3	Ratio	Mold	Kiln	Leng
4				
5				
6				



*Part C – Random number generation.*

Using the formula  $=2 \times \$D\$1 \times \text{Rand}() - \$D\$1$  to generate random errors gives a result similar to the following. Remember, your values will be different to these, and to everyone else's!



	A	B	C	D
1	Aim	200	Error	0.5
2				
3	Ratio	Mold	Kiln	Leng
4	0.45	-0.4	0.42	
5	0.24	-0.2	-0.4	
6	-0.2	0.12	-0.4	
7	0.12	0.0	-0.1	
8	0.04	5e-3	0.06	
9	-0.2	-0.3	-0.1	
10	-0.5	0.45	0.33	
11	-0.3	0.42	-0.3	
12	-0.3	0.49	0.23	
13	0.16	0.07	0.28	
14	0.20	0.46	-0.1	

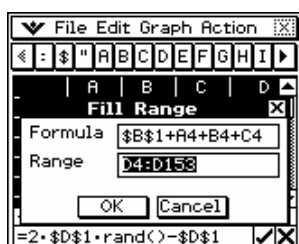
Answers.

- The largest error caused by the kiln in this batch of pavers is 0.4984 mm. Your answer will be different, but should be close to 0.5 mm (or -0.5 mm).
- My shortest paver has errors of -0.499 mm, -0.245 mm and -0.375 mm. This will give it a length of  $200 - 0.499 - 0.245 - 0.375 = 198.881$  mm.
- To get a paver that is exactly 198.5 mm long you would need all three errors to be exactly -0.500, a very unlikely (but not impossible) result



*Part D – Finding paver lengths.*

By summing the intended paver length, in B2, with the error values, in columns A to C, the actual paver lengths are calculated.



	B	C	D	E
1	200	Error	0.5	
2				
3	Mold	Kiln	Length	
4	-0.4	0.42	200.51	
5	-0.2	-0.4	199.64	
6	0.12	0.4	199.52	

# How long is a 200 mm paver?

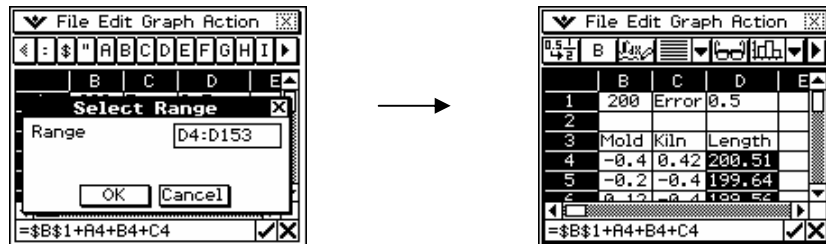
## Checkpoints

### Activity 3 – How long are your 200 mm pavers?

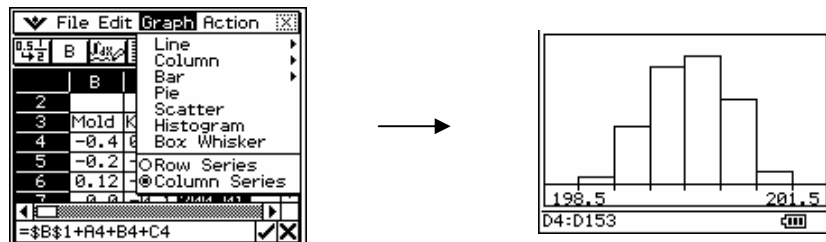


Answers.

1. By tapping Edit : Select Range

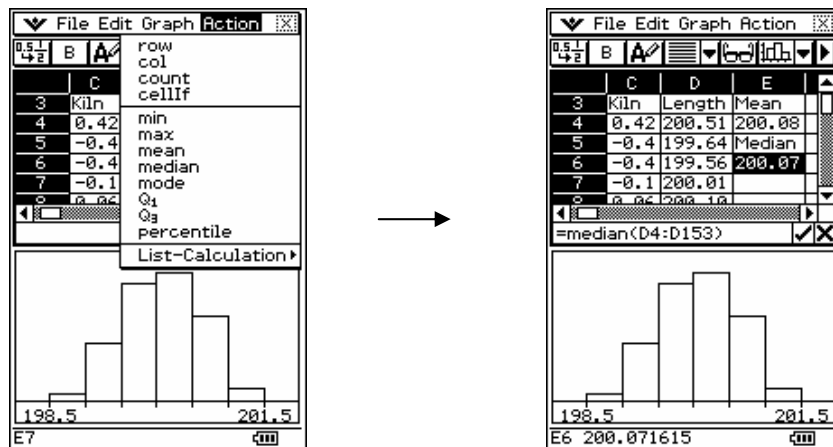


We can draw a histogram of our paver lengths.



2. This histogram is approximately bell shaped, and in general seems to resemble the histogram of the lengths of the 50 paver studied in Activity 1.

3. Commands for calculating measures of centre can be found in the Action menu. Tap on your choice of measure and enter the cell range that contains the data. Add labeling cells (shown above the calculation cell) as appropriate.



4. The graphs of both sets of paver lengths are similar. Both are centred around 200 mm and are roughly bell-shaped.

# How long is a 200 mm paver?

## Checkpoints




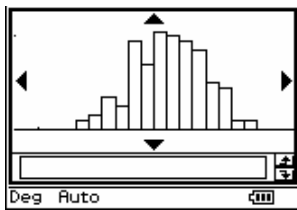
### Activity 4 – Making more pavers.

#### Answers.

- By entering a new maximum error value (0.25) in D1, 150 new paver lengths are calculated.

	C	D	E
1	Error	0.25	
2			
3	Kiln	Length	Mean
4	-0.2	199.83	200.00
5	-0.2	199.92	Median
6	-0.2	199.91	199.99
7	0.0	200.07	
8	-7E-3	200.29	
9	0.11	200.28	

- Using  mode the new paver lengths can be analysed.

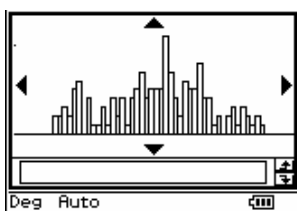


Stat Calculation	
$\bar{x}$	=200.01375
$\Sigma x$	=30002.062
$\Sigma x^2$	=6000836.3
$s_{x\bar{x}}$	=0.2725804
$s_{x\bar{x}-1}$	=0.2734935
$n$	=150
minX	=199.33493
Q1	=199.8311

Stat Calculation	
Med	=200.02551
Q3	=200.2077
maxX	=200.656
Mode	= ModeStat
ModeN	=150
ModeF	=1

These paver lengths have the same centre (both mean and median close to 200 mm) and the same shape (approximately bell shaped) as the previous batch. The new lengths are significantly less spread than the previous batch, with a standard deviation of 0.2726 mm, compared to the previous standard deviation of 0.5277 mm. Based on this, we can say that the change in maximum error value has decreased the variation of the 150 paver lengths, but has not changed the centre or shape of distribution of the paver lengths.

- Repeating this for an maximum error value of 1 mm,



Stat Calculation	
$\bar{x}$	=199.9585
$\Sigma x$	=29993.776
$\Sigma x^2$	=5997680.5
$s_{x\bar{x}}$	=1.0635979
$s_{x\bar{x}-1}$	=1.0671611
$n$	=150
minX	=197.8091
Q1	=199.23396

Stat Calculation	
Med	=200.07365
Q3	=200.72537
maxX	=202.18185
Mode	= ModeStat
ModeN	=150
ModeF	=1

We can see that, once again, shape and centre are unaffected by the new maximum error value. As could have been predicted, the increased error value has increased the variation within the paver lengths, with a standard deviation of 1.064 mm, compared to 0.5277 mm for the 0.5 mm error factor pavers and 0.2726 mm for the 0.25 error factor pavers.

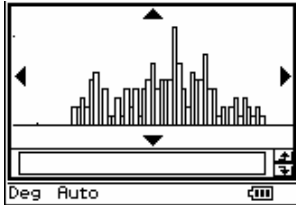
# How long is a 200 mm paver?

## Checkpoints

4. Leaving the maximum error value as 1 mm and changing the Aim in B1 to 170 mm our new pavers look like

	C	D	E
1	Error1		
2			
3	Kiln	Length	Mean
4	-1.0	168.97	169.80
5	0.88	170.47	Median
6	0.55	168.94	169.75
7	0.85	170.61	
8	-0.8	168.09	
9	0.24	169.46	

5. The following information can easily be obtained about this new batch,



Stat Calculation	
$\bar{x}$	=169.9585
$\Sigma x$	=25493.776
$\Sigma x^2$	=4333053.9
$\sigma^n$	=1.0635979
$\sigma^{n-1}$	=1.0671611
n	=150
minX	=167.8091
Q1	=169.23396

Stat Calculation	
Q3	=170.23396
Med	=170.07365
Q1	=170.72537
maxX	=172.18185
Mode	= ModeStat
ModeN	=150
ModeF	=1

From this we can see that the change in the Aim has not affected the shape of the distribution of paver lengths (still bell shaped), and does not seem to have affected their variation (a similar standard deviation to previously).

Predictably, the change in Aim has altered the centre of the distribution of lengths to 170 mm (both mean and median close to 170 mm).