



Activity 8.2c – Range with Excel[®]

Purpose

After construction of the BD its time to make some trial shots, measure the range of the projectile, and make predictions for the range at different firing angles. This will help you mathematically predict what your device will do using MS Excel[®] to calculate and graph the theoretical and actual range of the Ballistic Device (BD).

Equipment

Excel[®]
Device
Tape Measure

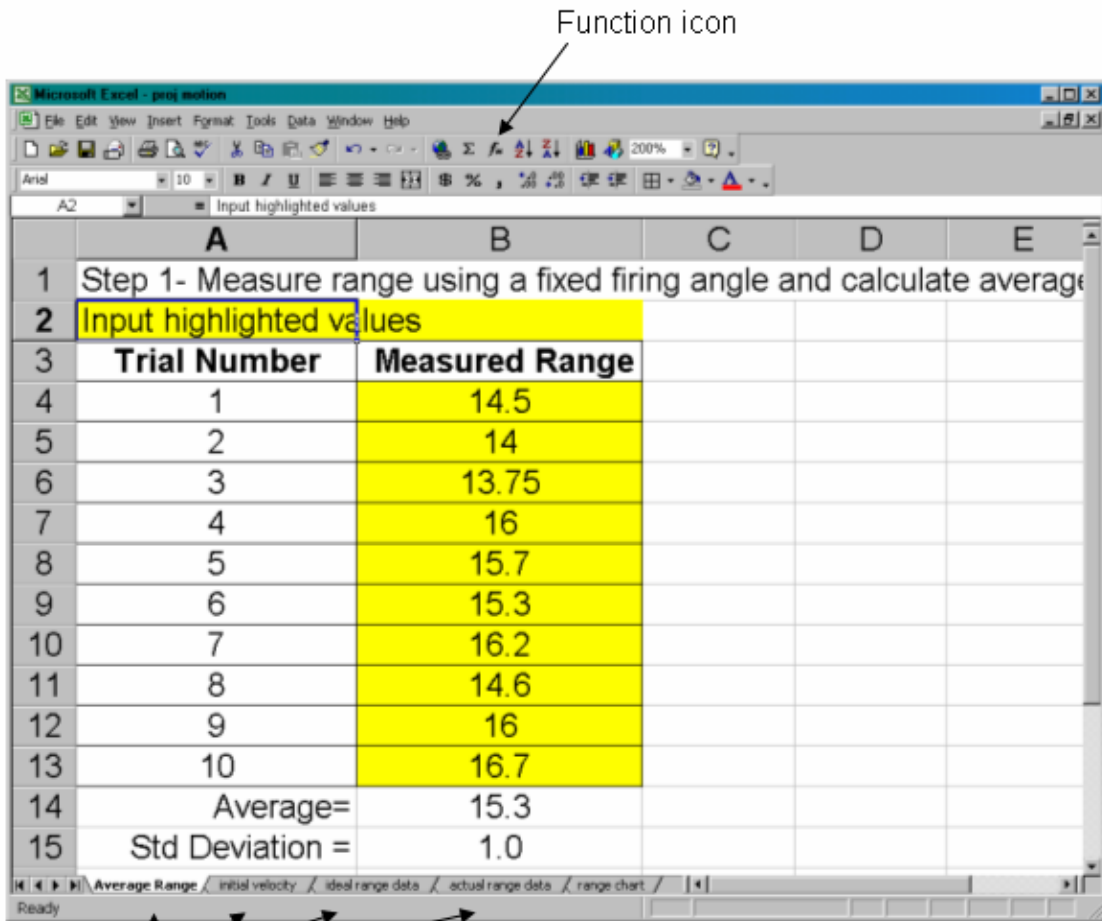
Procedure

Step 1:

Make 10 trial shots holding the firing angle constant.

Calculate the average and standard deviation of the data set using MS Excel[®]. Use Excel[®] built in functions:

From the tool bar select f_x . Under statistical select “Average” and “Stdev” in cells B14 and B15, respectively. Select the cells containing the data.



Note one sheet for each step

Step 2:

Use the kinematics equations to calculate the initial velocity of the projectile knowing the average range and the firing angle from step 1.

$$v_i = \sqrt{\frac{-gx}{\sin 2\theta}}$$

Use the following Excel® formula in cell D10:

$$=\text{SQRT}(D5*D7/\text{SIN}(\text{RADIANS}(2*D6)))$$

↑ Square root function ↑ Sine function ↑ Radians to degrees conversion function

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F
1	Step 2- Calculate the initial velocity from average range and angle.					
2	Input highlighted values					
3						
4	Inputs	Variable	Units	Value		
5	Average Range	x	feet	15.3		
6	Firing Angle	theta	degrees	30		
7	Accel from gravity	g	ft/sec^2	32.2		
8						
9	Outputs					
10	Initial Velocity	vi	ft/sec	23.8		
11						

Link this cell to the range calculation on sheet "Average Range"

Step 3:

The initial velocity can then be used to predict the range for different values for the firing angle. Rearrange the same equation to solve for the range knowing the initial velocity and firing angle.

$$x = \frac{-v_i^2 \sin 2\theta}{g}$$

Use the following Excel[®] formula in cell B3:

$$='initialvelocity'!\$D\$10^2*\text{SIN}(\text{RADIANS}(2*A3))/'initialvelocity'!\$D\$7$$

Notes:

'initial velocity!' appears when you select a cell from another sheet.

The \$ in \$D\$10 and \$D\$7 fixes the address of the cell so it does not increment when the formula is copied to other cells.

Copy the formula to cells B3 to B13 using copy and paste commands.

	A	B	C	D	E	F	G
1	Step 3- Calculate Ideal Range at different firing angles knowing initial velocity						
2	Angle (degrees)	Range (feet)					
3	0	0.0					
4	10	6.0					
5	20	11.3					
6	30	15.3					
7	40	17.4					
8	45	17.6					
9	50	17.4					
10	60	15.3					
11	70	11.3					
12	80	6.0					
13	90	0.0					

Step 4:

Launch projectiles 3 times at different firing angles, record the range of each launch.

Calculate Average Range and standard deviation similar to step 1.

Use the following Excel[®] formula in cell E4: `=AVERAGE(B4:D4)`

Use the following Excel[®] formula in cell F4: `=STDEV(B4:D4)`

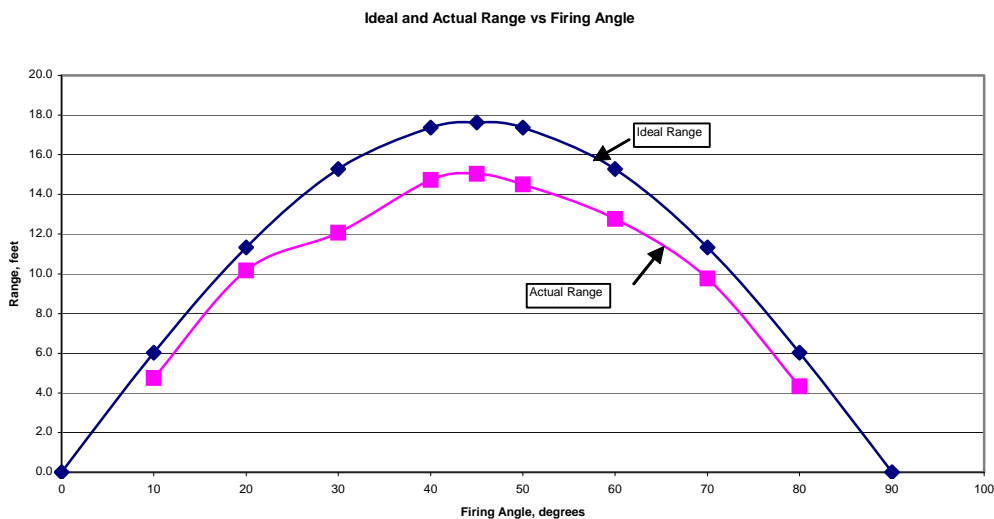
Copy the formula to cells E5 to F12 using copy and paste commands.

	A	B	C	D	E	F
1	Step 4- Record Actual Range at different firing angles					
2	Input highlighted values					
3	Angle (degrees)	Range 1 (feet)	Range 2 (feet)	Range 3 (feet)	Average Range (feet)	Std Deviation (feet)
4	10	4.5	4.75	5	4.8	0.3
5	20	9.5	10	11	10.2	0.8
6	30	12.2	13	11	12.1	1.0
7	40	14.7	15.2	14.3	14.7	0.5
8	45	15.4	15	14.7	15.0	0.4
9	50	14.3	14.7	14.5	14.5	0.2
10	60	12.5	13.2	12.6	12.8	0.4
11	70	9.5	9.8	10	9.8	0.3
12	80	3.5	4.5	5	4.3	0.8

Step 5:

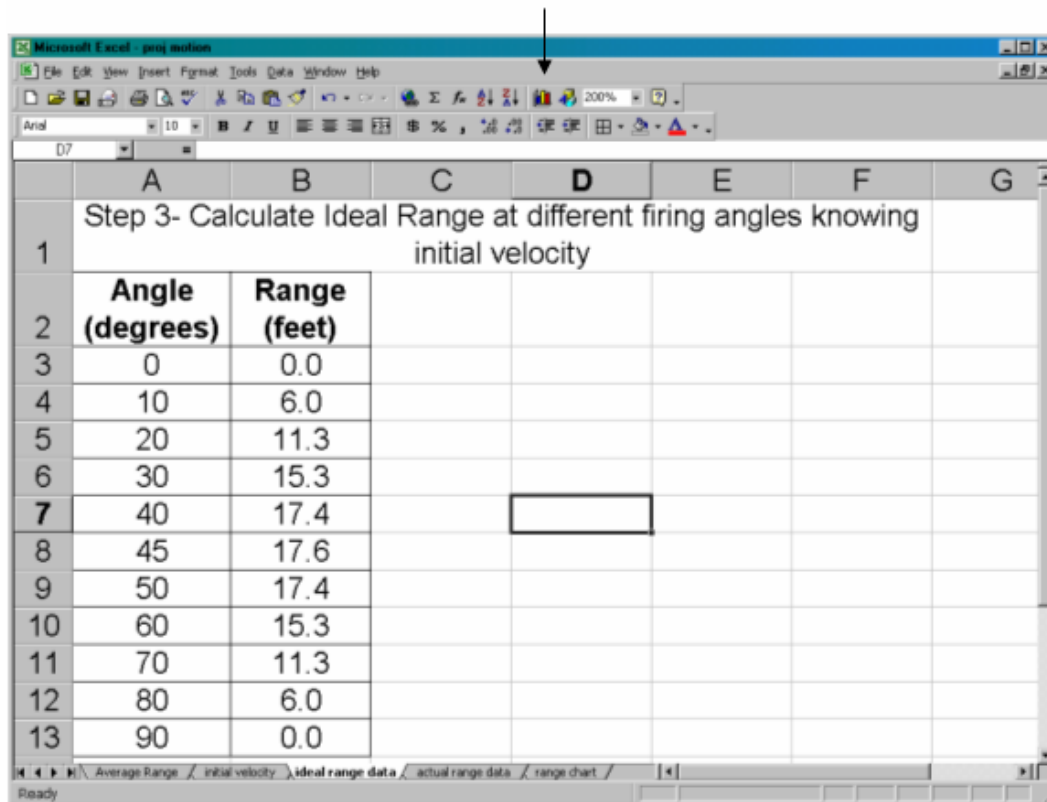
Create an xy scatter chart of both the ideal and actual ranges from steps 3 and 4.

First use the Chart wizard to create a chart of the ideal range versus angle, and then add a chart of actual range onto the same chart. The final chart is shown below.

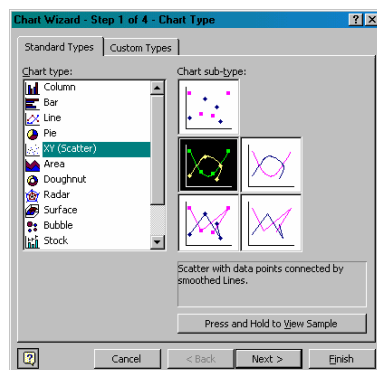


To create a chart from the chart wizard select cells A3 to B13 and click on the chart wizard icon.

Chart wizard icon



Select XY (scatter) chart with data points connected by smoothed lines.



Label the axes and add the chart on a new sheet.

Go to the sheet containing the new chart. From the top menu...*chart.. add dat.*

Select cells from A4 to A12 and E4 to E12 from the “actual range data” sheet from step 4. Note to select groups of cells that are not adjacent, you must hold down the *ctrl-key* while dragging the left mouse key.

Add cells as a new series and select x values in 1st column.

