

# Analyzing data using your TI-83 or TI-84 calculator

## Introduction/Setting up your calculator

In these instructions, if a key is a “second function” key, the keystroke instructions will be in square brackets and requires you to press the  $\text{2nd}$  key first, e.g. to get  $\text{[STAT PLOT]}$  type  $\text{[2nd] [Y=]}$ .

1. Get your calculator in the correct mode. Press  $\text{[MODE]}$   $\text{[2]}$   $\text{[2]}$  then select **FUNC** for the graphing mode.

**Note:** This is also where you can change from **RADIANS** to **DEGREE** mode if you don't get 1.0 for  $\sin(90)$ .

### A: Data is stored in lists

Experimental data is stored in what your calculator calls **Lists**. These are labeled L1, L2, up through L6. You can see the data in lists by using the  $\text{[STAT] 1}$   $\text{[EDIT]}$ ... key sequence. This will display a screen similar the image on the right.

| L1   | L2    | L3    | 6 |
|------|-------|-------|---|
| 0    | 00306 | 00306 |   |
| .25  | 80818 | 80306 |   |
| .5   | 81531 | 81325 |   |
| .75  | 82144 | 82756 |   |
| 1    | 82756 | 849   |   |
| 1.25 | 82369 | 88656 |   |
| 1.5  | 82881 | 11025 |   |

List window

1. To prepare for graphing, clear any old, unneeded data already in your calculator:

- Press  $\text{[STAT] 1}$   $\text{[EDIT]}$ ... This will display the first three lists (L1, L2, and L3) on the screen. If any of them are not blank and you want to clear them, use the  $\text{[↑]}$  and  $\text{[↓]}$  arrows to highlight the title of a list. Then press  $\text{[CLEAR]}$   $\text{[ENTER]}$  to clear.
- Press  $\text{[2nd] [MODE]}$  to  $\text{[QUIT]}$ .

### B: Entering data into a list

- Decide which list will contain your data, then enter your data:
  - $\text{[STAT] 1}$  to get the List editing display.
  - If needed, use the arrow navigation keys to get to the first entry line in the list number you want: L1, L2, etc.
  - After entering each number, press the  $\text{[ENTER]}$  key to move to the next entry line for that list.

## D: Manually setting the scale for your graph

$\text{[ZOOM] 9}$  is very handy in science labs because it zooms to the region of the graph with your experimental results. But often you will need to adjust the scale of the graph to see the origin (0,0) and to set the divisions of your scale into easy to understand values. Use the following directions to adjust the scale to the “best” values.

- Use the  $\text{[WINDOW]}$  key to see the scale of the current graph (example on right):
- Set the  $X_{min}$  and  $Y_{min}$  both to 0 (unless you have data in the negative region of either of these axes, then set it to a negative number just below your lowest value).
- Look at your X data, then select an  $X_{max}$  value that is just above your highest value, but also of a number than can easily be divided into 8-10 portions of a familiar value (e.g. your divisions will be 0.1, 0.2, 0.5, 1, 2, 5, etc.).

| WINDOW    |         |
|-----------|---------|
| $X_{min}$ | =-.25   |
| $X_{max}$ | =2.75   |
| $X_{scl}$ | =1      |
| $Y_{min}$ | =-.1311 |
| $Y_{max}$ | =3.6611 |
| $Y_{scl}$ | =1      |
| $X_{res}$ | =       |

## C: Graphing two lists

1. To graph two lists, **they must contain the same number of data points**. Scroll to the bottom of your lists and if one has more data points than the other, check your data to see if you have missing data.

2. **Clear the graphs:**

- Press  $\text{[Y=]}$  to display the *Equation* window.
- If there are any functions (equations) listed, clear them by using the  $\text{[CLEAR]}$  key.

| Plot1  | Plot2 | Plot3 |
|--------|-------|-------|
| $Y_1=$ |       |       |
| $Y_2=$ |       |       |
| $Y_3=$ |       |       |
| $Y_4=$ |       |       |
| $Y_5=$ |       |       |
| $Y_6=$ |       |       |
| $Y_7=$ |       |       |

Equation window

3. Set the parameters for your graph:  $\text{[2nd] [Y=]}$  for  $\text{[STAT PLOT]}$ .

4. If **Plot2** or **Plot3** are **On**, in most cases you will need to turn them off before you graph.

| STAT PLOTS    |    |    |
|---------------|----|----|
| 1:Plot1...On  | L1 | L2 |
| 2:Plot2...Off | L1 | L3 |
| 3:Plot3...Off | L1 | L2 |
| 4↓PlotsOff    |    |    |

Window showing all three plots

5. Click **1** to open the  $\text{[STAT PLOT]}$  options window for **Plot1**.

6. In **Plot1**, the first two rows should be set to **On**, and scatter-plot:  $\text{[2]}$ . The last row (the marker) should be the open square:  $\text{[4]}$ .

| Plot1              | Plot2 | Plot3 |
|--------------------|-------|-------|
| On                 | Off   |       |
| Type: $\text{[2]}$ |       |       |
| Xlist: L1          |       |       |
| Ylist: L2          |       |       |
| Mark: $\text{[4]}$ |       |       |

$\text{[STAT PLOT]}$  options window

7. In **Xlist**, press  $\text{[2nd] [L1]}$  (or other list number to plot on X).

8. In **Ylist**, press  $\text{[2nd] [L2]}$  (or another list number).

9. Press  $\text{[ZOOM] 9}$  to select **9:ZoomStat**. Your calculator should now show a graph zoomed in on the area that contains your data.

10. Before you go further, check the data points on your graph. If any of them don't look like they fit the pattern of the rest, you may want to go back to your lists and check to see if you made an error typing your data into your lists.

4. Set the  $X_{scl}$  value to the value of this 8 to 10 divisions of your  $X_{max}$ .

- For example, if your maximum data is 18.8, and you chose 20 as your  $X_{max}$ , then set your  $X_{scl}$  value to 2, which is 1/10 of 20.

5. Repeat Steps 3 & 4 for the  $Y_{max}$  and  $Y_{scl}$  values.

- To avoid confusion, when possible use the same  $X_{scl}$  and  $Y_{scl}$ . In some case you may need to use different scales for X and Y (e.g. if X range is 0-6s but Y range is 0-100m).

6. **Xres** controls how the  $\text{[TRACE]}$  key moves: 1 traces every pixel on the screen, 2 every second pixel, etc. Keeping this at 1 is probably best.

7. Use the  $\text{[GRAPH]}$  key to see your new graph!

- Copy the graph into your lab, including the hash marks that show on your calculator (you do not need to add the grid dots on your sketch).
- Using the  $\text{[WINDOW]}$  display, label the hash marks so they correspond to your  $X_{scl}$  and  $Y_{scl}$ . Labeling to the maximum values of your X and Y axes.

## E: Fitting an equation to your data.

1. Press  $\boxed{\text{STAT}}$   $\boxed{\text{D}}$  to open the CALC menu.
2. Select your "regression" type:
  - a. If your graph looks like a linear relationship, select 4:LinReg(ax+b)
  - b. If your graph looks like half a parabola, select 5:QuadReg.
3. The regression type you selected above will display on the screen.
4. Press  $\boxed{2\text{nd}}$   $\boxed{\text{L1}}$   $\boxed{,}$   $\boxed{2\text{nd}}$   $\boxed{\text{L2}}$   $\boxed{,}$   $\boxed{\text{VARS}}$   $\boxed{\text{D}}$  1 to display the VARS Y-VARS FUNCTION secondary menu, then press 1 to select Y1. (This example assumes you are using L1 and L2; the order is always x-axis variable, then y-axis variable) The screen should display one of the functions below:

```
LinReg(ax+b) L1,
L2, Y1
```

```
QuadReg L1,L2,Y1
```

5. Press  $\boxed{\text{ENTER}}$  and your results should show up in one of the formats below:

```
LinReg
y=ax+b
a=297.0947497
b=-28.25208995
```

```
QuadReg
y=ax^2+bx+c
a=417.703743
b=25.58731674
c=-.0299343186
```

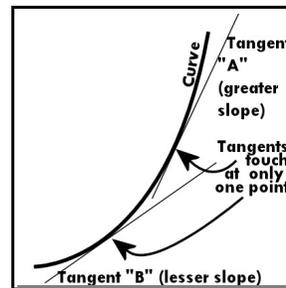
6. Copy the results into your lab book. **Write neatly and put a box around this regression solution.**
  - a. If your calculator displays R or  $R^2$  values, these represent statistical methods of determining how well the equation matches the data.
7. Use the  $\boxed{\text{GRAPH}}$  key to visually check how well your data fits your equation (it may take a few seconds to add the equation's line to the graph).
8. Are you still satisfied with your choice of regression type? If not, go back and try the other to see if it is a better visual fit.
9. **When you have a satisfactory result, re-write the equation using the experimental concepts and the correct units for each of the a, b, c numbers. Write neatly and box this model.**

## F: Using the Table to solve for variables

1. You must have your equation in the  $\boxed{\text{Y=}}$  equation list to use this section (see "E: Fitting an equation to your data").
2. Set the calculator to "Ask" you for one of the variable:  $\boxed{\text{[TBLSET]}}$  then set one of your variables to ASK and the other to Auto.
3. Use  $\boxed{\text{[TABLE]}}$  to plug in your "ask" variable and have the calculator solve for the other one.
4. Note: If you have a Quadratic equation that has an up- or down- opening parabola, since there are two possible independent variable solutions for each dependent variable, you must "Ask" for the independent regardless of which variable you want to solve for.

## G: Finding the slope at specific times on a curve

On a linear graph, the slope is the same at all points, but on a curved graph the slope is changing. On a x/t graph you can use the  $\boxed{\text{[DRAW]}}$  key to create tangents (lines that touch the curve at only one point, but don't cross it) to find the *instantaneous velocity* for selected clock times.



1. Press  $\boxed{\text{[GRAPH]}}$  to display your graph.
2. Press  $\boxed{2\text{nd}}$   $\boxed{\text{[PRGM]}}$  to get  $\boxed{\text{[DRAW]}}$ , then select 5:Tangent(
3. Use the arrow keys to move the cursor ("X") along your curve until it is closest to your first data point (it will likely *not* be right on it).
4. When the tangent is finished drawing, you will see two equations at the bottom left:
  - a.  $x = [\text{some number}]$  This number is the value of your "x" variable (time) for this tangent.
  - b.  $y = [\text{some number}] x + [\text{some other number}]$ 
    - i. Notice the "y=mx+b" format: The first number is the slope of that tangent.
5. Record both the time value and the corresponding slope (velocity) in your data table.
6. Repeat these procedures for all of your data points.
7. Enter your new data (v and t) in Lists 3 and 4. Conduct a **LinReg (ax+b)** on this data and record your results.

## H: Filling a list using a formula that includes another list

In some cases you will want to make calculations that include data already in a list (in this example, the difference between the each data point)

1. Type  $\boxed{2\text{nd}}$   $\boxed{\text{[STAT]}}$  to get  $\boxed{\text{[LIST]}}$
2.  $\boxed{\text{D}}$  to get to OPS menu (for OPERATIONS)
3. Press 7 for  $\Delta\text{List}(\text{ )}$
4. The display will show  $\Delta\text{List}(\text{ )}$
5. Type  $\boxed{2\text{nd}}$  2 --or the number of the list you want the differences of--  $\boxed{\text{[STO]}}$   $\boxed{2\text{nd}}$  --then 3 or the number of the list to store in--  $\boxed{\text{[ENTER]}}$ .
  - a. Note: In some cases you will end with different numbers of data in the two Lists. To graph, delete the extra using the  $\boxed{\text{[DEL]}}$  key until the ending lines \_ \_ \_ are parallel.

## Notes

- If you are missing any lists, enter the following key sequence to unhide the lists:  $\boxed{\text{[STAT]}}$  5 then  $\boxed{\text{[ENTER]}}$ .
- To set your calculator to display  $R^2$  and R (correlations) values of your regressions: Press  $\boxed{2\text{nd}}$   $\boxed{0}$  to get  $\boxed{\text{[CATALOG]}}$ , then D to jump down to the catalog commands that start with D. Next find and highlight **DiagnostiCsOn**, the press  $\boxed{\text{[ENTER]}}$  twice.
- Turn on the grid:  $\boxed{2\text{nd}}$   $\boxed{\text{[ZOOM]}}$  for  $\boxed{\text{[FORMAT]}}$ . Then highlight **GridOn** and hit  $\boxed{\text{[ENTER]}}$ .
- If your  $\boxed{\text{[GRAPH]}}$  or  $\boxed{\text{[Y=]}$  screens have extra tabs at the bottom, you may be running the Application "Inequalz." To quit this application, type  $\boxed{\text{[APPS]}}$ , then scroll down to highlight **Inequalz**, then  $\boxed{\text{[ENTER]}}$ , then select 2: **Quit Inequalz**.