

Thinking about that display

Nevil Hopley



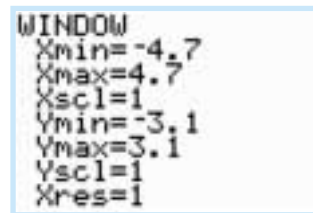
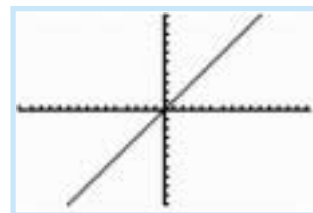
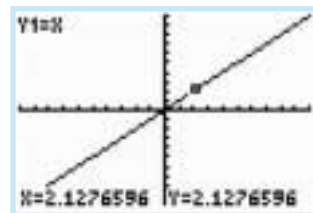
Nevil Hopley

Nevil Hopley is Head of Mathematics at George Watson's College, Edinburgh. He also runs Calculator Software (www.calculatorsoftware.co.uk), a small company that supplies programs for TI graphics calculators that help teach and consolidate maths skills.

Here he presents ideas used in a recent training session for teachers that can be used equally well in the maths classroom.

The calculator is not a magic black box that always produces 'right' answers. It's important to stress that you always need to check what you see on the screen and treat it with a measure of intelligent scepticism. These short demonstrations can be used to provoke real mathematical thinking in the context of understanding how the calculator works.

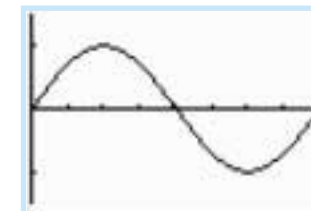
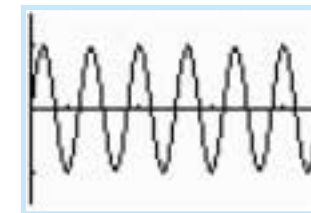
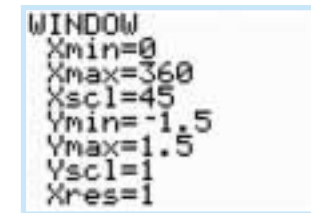
Example 1



- ▶ Reset the calculator.
- ▶ Type in **Y1=X**, press **GRAPH** then press **TRACE**.
- ▶ By moving the arrow around, it's clear that the co-ordinates are not nice numbers, as well as the line not being at 45 degrees.
- ▶ Ask the audience if they know why this is!
- ▶ Press **ZOOM** and select **5:ZSquare**. This sorts out the 45 degree problem, but still there are yucky numbers when tracing points.
- ▶ Press **ZOOM** and select **4:ZDecimal**. This sorts out both problems, but you won't always want such a small window range.
- ▶ Press **WINDOW** to see that the **Xmin/Xmax** and **Ymin/Ymax** limits point to the screen being 95 pixels wide by 63 pixels high.
- ▶ Try changing the settings from ± 4.7 and ± 3.1 to 47 and 31 or other values to produce a nice window display with friendly coordinates. You may want to change **Xscl** and **Yscl** too.

The moral of the story: *make the calculator's display work for you!*

Example 2



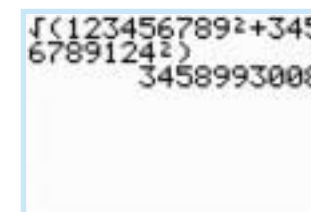
- ▶ Hide the display from your audience and configure the calculator like this:
 - **Y1=sin(100X)**
 - **Window:**
Xmin=0, Xmax=360, Xscl=45, Ymin=-1.5, Ymax=1.5, Yscl=1
- ▶ Now press **GRAPH**, and reveal the screen display to your audience
- ▶ Show them that the calculator is in Degree **MODE**, that the **WINDOW** ranges are "normal" and then ask the group to conjecture what the function is.
- ▶ They *should* volunteer $Y1=\sin(6X)$
- ▶ Now without pressing **Y=**, point out that, if $Y1$ really is $\sin(6X)$, then if the window is changed so that X goes from 0 to 180, then we should only see 3 cycles.
- ▶ Change the Window range from 360 to 180 and press **GRAPH** – it's not as expected!
- ▶ Talk about what has happened!
- ▶ Now press **Y=** to show what the function really was: **Y1=sin(100X)**.
- ▶ Go on to change the function to **Y1=sin(95X)**, set the Window range back to X going from 0 to 360 and then press **GRAPH**

You see what appears to be one single cycle of the sine function but, in fact, the first pixel has been plotted from the first cycle, the second pixel from the second cycle, and so on.

We have, in effect, a perfect match of pixels to points!

The moral of the story: *don't always trust the calculator's display – think for yourself too!*

Example 3



- ▶ The numbers 31, 480 and 481 form a Pythagorean triplet because $31^2 + 480^2 = 481^2$. Check this on the calculator
- ▶ Now type in the calculation shown in the screenshot. It appears that this is also a very large Pythagorean triplet!
- ▶ Replace the second squared number with 3456789125. Can this really be another Pythagorean triplet?
- ▶ This, however, is not the case as the calculator can only work to **14 significant figure** accuracy. When squaring a 9 digit number, you typically get an 18 digit number of which the calculator discards the last few digits. Adding two large numbers together won't change the magnitude of the answer by any significant amount, but when it is square rooted, the displayed answer is not the true answer given that some digits have been discarded in the process.

The moral of the story: *don't trust the calculator with big numbers – think for yourself too!*