

1. Introduction TI InterActive!

Goal of the task

The goal of this unit is to help students become familiar with the TI InterActive! environment. They should learn to find their way in this software package and be able to use the built-in help features to use the program independent of the teacher.

The unit is split up into five main tasks:

- A TI InterActive! as a word processor
- B TI InterActive! as a calculator
- C TI InterActive! as a graphing environment
- D TI InterActive! as an algebra environment
- E TI InterActive! as a function investigator

A solution file is provided. If the teacher wants to restrict students' access to the solution file then the hyperlinks need to be removed.

Target group and required time

There is no clearly defined target group for this unit, however the main tasks A and B, parts of C and the first part of D are recommended for ninth grade and the second part of D and E for grade 10. Each of the tasks requires about one lesson in the computer lab.

Preliminary TI InterActive! skills

Students do not need any skills in using TII (TI InterActive!), but basic skills in using Windows applications are useful.

Preliminary mathematical skills

The required preliminary mathematical knowledge is minimal in tasks A and B. For task C, the students should be familiar with quadratic formulas and parabolas. In task D, the general solution of a quadratic equation appears, as well as some more advanced algebraic procedures. For task E differentiation is used although this part of the unit can be skipped easily.

File organization

The task consists of the following linked TII files:

- IntroNotebook.tii: This file is the starting point, containing hyperlinks to other files and also the file in which students record solutions.
- IntroMainTaskA.tii: the file containing main task A.
- IntroMainTaskB.tii: the file containing main task B.
- IntroMainTaskC.tii: the file containing main task C.
- IntroMainTaskD.tii: the file containing main task D.
- IntroMainTaskE.tii: the file containing main task E.
- IntroSolution.tii: contains the solutions.

The hyperlinks only work if files are installed in the map c:\TII\Intro.

Classroom organisation

We suggest a short introduction to TII of about 10 minutes where students are shown some important and impressive features of the software. The general structure of the menu bars may also be explained.

Students can then work through the tasks. We recommend some plenary summaries, demonstrations and student presentations to guarantee a kind of convergence of machine techniques and to discuss interesting findings.

Technical hints

Students start by opening the notebook file in TII. They then open the main task in a separate window, using the hyperlink. In fact, two versions of TII are now activated. By means of a right mouse click in the Windows menu bar, the option 'Cascade Windows' offers opportunities for switching easily between the files. However, if the same hyperlink is used twice, two versions of the same file will be opened. This may be a source of confusion and therefore requires some attention by the teacher.

Because TII only supports absolute hyperlinks and not relative links, the links need to be adjusted after installation of the files, for example on the school network.

Didactical suggestions

While the students are working, alone or in pairs, we recommend that teachers ask them to carefully observe the result obtained. For example, the teacher could ask students if they understand the TII output, if the output could have been found in another way, or if the answer makes sense.

The students may try to skip the questions that address explanations of the TII output, so it is up to the teacher to stress the importance of the interpretative skills.

1.2 Main task B: TI InterActive! as a calculator

intro

TI InterActive! is a perfect mathematical assistant. One of the first mathematical features that you might want to use is the regular calculation feature. Keep in mind that TI InterActive! calculates exact as well as approximate results! Furthermore, big numbers are no longer a problem.

task

If you want to use TI InterActive! as a calculator, you need to open the Math Palette.

B1. Open the Math Palette by pressing . Move the Palette so that you can read this text.

Two things happened simultaneously. First, you see a rectangle around your cursor. This is the Math Box, where you can enter your calculation. It will also contain the result. Second, you see the Math Palette, which looks somewhat like an ordinary calculator. You use it for entering numbers, and later formulas and commands. The Math Palette can be moved to any convenient position on your screen.



The Input and Output fields on the lower side of the palette allow you to control the input and output styles. The More field gives access to advanced settings.

You can close both the Math Box and the Math Palette with Esc.

B2. Just for practise: close the Math Box and Palette, and then open it again.

B3. Enter in your notebook file: Task B3.

Then open a Math Box and enter: 11^2 . Finish with Enter.

You see that the square sign is represented nicely, and that the answer appears immediately in red.

A new Math Box is opened automatically, and the Math Palette is still there.

The Math Palette contains a button with ANS on it. This stands for the answer of the last calculation.


B4. Enter in the open Math Box: $\sqrt{\text{ans}}$.

Verify the calculation that was carried out by TI InterActive!.

B5. Calculate 111^2 , 1111^2 , 11111^2 . Nice pattern, isn't it?

If you want to get rid of a previously made Math Box, just click on it and press the Del button or the Backspace on your keyboard.

Fractions can be done as well. A fraction such as $1/3$ can be entered like exactly this way in a Math Box.

Another option is to start with the fraction bar by pressing  in the Math Palette.


B6. Open a Math Box in your notebook file and enter: $1/3 + 1/5$.

Verify the answer by hand!

The answer is a fraction again. If you want a decimal answer, you can use the command **approx**, which is short for approximate.

B7. Enter in a Math Box: **approx(ANS)**.

If an approximation with more decimals is required, one can change the settings.

B8. Press the Mode Settings icon  in the mathematics toolbar. Set the number of digits to Fixed 12 in the Display Digits field and click OK. Open a new Math Box and enter: **approx(1/3+1/5)**. What is the result of changing the Mode Settings?

B9. Calculate $1/3+0.5$.

Explain why you get a decimal answer without using **approx**.

In a calculation, the position of parentheses may determine the results. Be wary of this!

B10. Open a Math Box. You can also use **Ctrl-M** for that.

Calculate $1+2/3*4$.

How did TI InterActive! find the result?

B11. Double-click on $1+2/3*4$ in the Math Box and change it into $1+2/(3*4)$.

Explain the difference in the outcome.

B12. Insert parentheses in $1+2/3*4$ so that the result is 4.

Change the position of the parentheses in order to get two different results.

You may know about factorials. For example, $10!$ ('10 factorial') is defined as $1*2*3*4*5*6*7*8*9*10$.

B13. Calculate both $10!$ and $1*2*3*4*5*6*7*8*9*10$. You should get the same result.


B14. Factorize the answer with **factor(ANS)**. You can either type in the word **factor**, or find it in the **Math Algebra** menu of the Math Palette.

Explain the two factors 5.

B15. Calculate $25!$ How many times does the factor 5 appear?

B16. Calculate a bigger factorial number, factorize it and explain the numbers of times the factor 5 is present.

Summary

For calculations you have to open a Math Box, which can be done with Ctrl-M or . The Math Box can be moved, deleted or edited. Commands can be typed in directly or picked from the Math Palette Menus.

We finish task B with two additional assignments.

B17. Carry out the following calculation by double-clicking on it and changing the 'Hide output' setting in the Math Palette:

$$6 - \frac{-1 - 3^2}{\frac{-5}{4}} + \sqrt{\frac{8}{9-7}}$$

B18. Try to find out a calculation yourself which contains each of the digits 1, 2, 3, ..., 9 once and not more than once. Have one of your colleagues carry out the calculation. The answer should be an integer value.


1.3 Main task C: TI InterActive! as a graphing environment


intro

TI InterActive! can be used as a graphing environment. It draws all graphs for you, in a fast and accurate way and in the colours you choose. Setting an appropriate viewing window is important for getting a good view of the graph.

task

Before we can graph a function, it first needs to be defined. You can do this with the command Define.


C1. In your notebook file open a Math Box with  and enter define $f(x) = x^3 - x$.

The icon  gives access to the Graphing window.


C2. Press .

Two windows pop up, a Functions window which contains the functions to be graphed, and a Graph window, where the graphs will appear.

C3. Enter $f(x)$ for $y1(x)$ in the Functions window. Immediately, the graph appears.

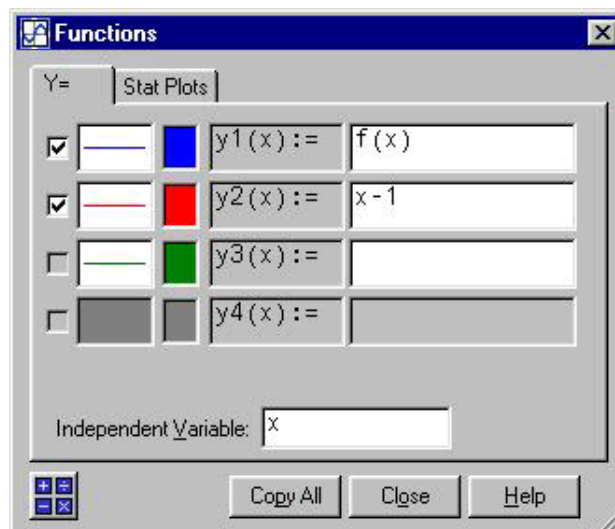
The viewing window is indicated by the numbers in the margin of the graph. You can either change these dimensions directly, or in the  window.

C4. Change the viewing window to $[-2, 2]$ by $[-3, 3]$.

C5. Press  in the Graph window. As a result, the Functions window is closed and the graph is copied into your notebook document. If you click on the graph window in the notebook file, you can change the dimensions of its appearance.

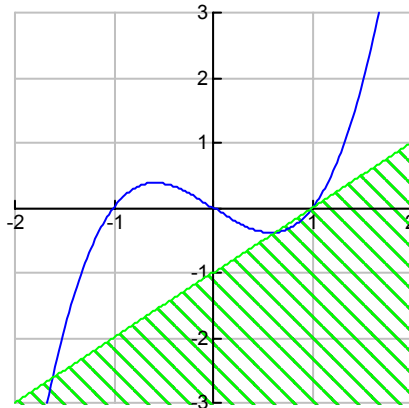
C6. Re-open the graph window by means of a double click.
Enter a second function $x - 1$ in $y2$. This graph appears immediately as well.

As you see in the picture below, you can define a function in the Home screen and refer to it in the Functions window, as was done for the function f . A second option is to enter the formula directly into the Functions window, as you did for function $y2$. You can choose the colour and the thickness of the graph. By means of ticking the box, you can activate or de-activate the function.



C7. Click on the colour to the left of y_2 and choose a colour that you like. Click on the line to the left of y_2 to change the style of drawing. Copy the graph into your notebook file.

Your graph might look like this, for example:




In the Graph window you see several buttons and options:

The first line offers options such as **Zoom** for changing the view of the graph and **Calculate** for calculating intersection points, zeros and extreme values.


The second menu bar offers icons, such as the  icon for animated drawing of graphs and the  symbol palette for entering expressions.

The third menu bar offers icons for calculations in the graph and window settings.

The fourth line contains the main buttons , ,  and .

The  button allows for tracing the curve to see the coordinates of the cursor position.



C8. Re-open the graph and use **Trace** to approximate the coordinates of the intersection points. You can use the arrows in the Trace Value window to move the cursor. Use **Close** to end tracing.

C9. Click on . This opens the Calculate Intersection window. Move the black cross towards one of the intersection points and choose **Calculate** in the Calculate Intersection window. Write down the coordinates of the first intersection point. Do the same for the second and the third points.

C10. Verify that $(1, 0)$ is the coordinate of an exact intersection point by calculating $f(1)$ and $y_2(1)$ in the notebook file.


C11. Enter $y_1(x) - y_2(x)$ as a third function in the Functions window. Explain why the graph of y_3 intersects the horizontal axis for the same values of x for which y_1 and y_2 intersect.

Summary

For graphing you have to open the Functions window and the Graph window by clicking on . You can scale the viewing window by setting the dimensions, either by entering the endpoints for x and y directly or by using .

We finish task C with three additional assignments.

C12. Define a function f : define $f(x) = -2x^2 - 2x + 12$ Draw the graph of f and find the coordinates of the zeros and the maximum.

C13. Enter $y1(x) := \sqrt{x^2 + 1}$ in the Functions window. The Symbol Palette  can be used to enter the square root sign. Graph $y2(x) := x$ and $y3(x) := -x$. Why do the lines seem to touch the curved graph?

C14. Enter $x^4 + b \cdot x^2 + 1$ | $b = \{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$ as function $y1$ in the Functions window: Using this instruction, the values $-4, 0, 3, \dots, 4$ are substituted into b . This leads to a 'sheaf' of graphs. Find an appropriate viewing window for this sheaf.


1.4 Main task D: TI InterActive! as an algebra environment

intro

In contrast to many graphing software packages, TI InterActive! also has algebraic features. It can rewrite algebraic expressions, solve equations and remove the calculational drudgery of algebra. It remains important, though, that you are fully aware of your problem solving strategies.

task

In Main Task A you used Math Boxes to carry out numerical calculations. In the same Math Boxes you can enter algebraic calculations. The Math Palette menus provide the commands.

D1. In your notebook file open a Math Box with  and enter $a + a$.
TI InterActive! automatically simplifies this as $2a$.

D2. Enter $a*b*c*a*b/c$.
Is the answer correct for all values of a , b and c ?

D3. Enter $\sqrt{x^2}$.
Also enter $\sqrt{x^2} | x > 0$ and $\sqrt{x^2} | x < 0$.
The vertical bar $|$ is the 'wherein-bar' or the 'with-bar'. It is a means to indicate a condition.

D4. The wherein-bar can be used for substitution. Enter for example:

$$x^3 | x = 2$$

$$x^3 | x = y$$

$$x^3 | x = \text{monkey}$$

$$x^3 | x = a + 1$$

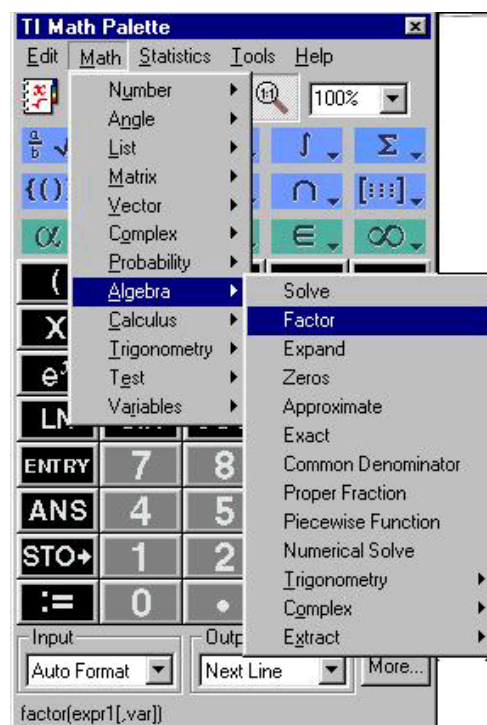
D5. You probably know that $a^2 + 2 \cdot a \cdot b + b^2$ can be written as $(a + b)^2$.
Enter $a^2 + 2 \cdot a \cdot b + b^2$. Nothing happens, as TI InterActive! does not know which of the two forms is the most simple for you.

If you want to get the second form in assignment D5, you need to use the factor command. There are two ways of entering this command; either just type it in, or select it from the Math Algebra-menu in the Math Palette. In this case, you first click on the Math button in the Math Palette to enter the menu for mathematical calculations. Then choose Algebra, and click on the Factor command in the pop-up menu. This method has the advantage of offering help concerning the syntax. In the last line of the Math Palette you see `Factor(expr [,Var])`, indicating that Factor should be followed by an expression between parentheses, with an optional comma and name of a variable.

D6. Enter `factor(a2 + 2·a·b + b2)`. Mind the multiplication sign \cdot between a and b .

If you do not enter the multiplication sign \cdot between a and b , TI InterActive! will interpret ab as one variable name.

D7. Verify that `factor(a2 + ab + b2)` does not give the same result as above.



D8. In some cases, you should add the variable to the factor command. For example, try:

```
factor(x2 - 2)
factor(x2 - 2, x)
factor(x2 - 2.0, x)
factor(x2 + y2 - 2·y + 1, x)
factor(x2 + y2 - 2·y + 1, y)
```

To do the opposite and expand the brackets, use the expand command. Like the factor command, it can be entered as such, or picked from the Math Algebra menu in the Math Palette.

D9. Enter in a Math Box: `expand((a + b)2)`.
Mind the parentheses!

D10. Expand the parentheses in $(a + b)^{10}$.

D11. Factor the answer of the previous assignment.

D12. Find a value of a so that $(x - a)^3$ equals $x^3 - 12x^2 + 48x - 64$.

TI InterActive! can solve equations. The command, **Solve**, can be found in the Math Algebra menu of the Math Palette. You can also type in the word **Solve** using your keyboard. The syntax for solving an equation is `solve(equation, unknown)`.

D13. Enter in a Math Box: `solve(x2 = 5, x)`.
Approximate the solutions.
What happens if you enter `solve(x2 = 5.0, x)`?

D14. Solve the generic quadratic equation $a \cdot x^2 + b \cdot x + c = 0$.
Do you recognize the solution?
What happens if you solve the equation with respect to a instead of x ?

Summary

Important algebraic features of the TI InterActive! algebra module are:

- the automatic simplification that occurs in the Math Box,
- the commands factor and expand, which can be typed in or selected from the Math Algebra menu in the Math Palette,
- substitution, which is done with the 'wherein-bar' | ,
- the solve command for solving equations. The syntax is `solve(equation, unknown)`.

Two additional assignments end this task.

D15. Enter $\frac{\frac{2}{3}a + 2b}{a + 3b}$ and explain the simplified form.

D16. In task C you defined the functions $f(x)$ and $y2(x)$:

```
define f(x) = x3 - x
define y2(x) = x - 1
```

You found the intersection of the two graphs.

Verify the results you found with a solve command: `solve(f(x) = y2(x), x)`.

Approximate the solutions.

1.5 Main task E: TI InterActive! as a function investigator

intro

In Main Tasks A - D, you learned several TI InterActive! techniques. In this final part of the introductory unit, you will combine these techniques and apply them to investigate a function.

task

In this task you will investigate the function f with define $f(x) = \frac{4x^2 + 7x}{8x - 2}$.

- E1. Enter the function in your notebook file.*
- E2. Select an appropriate viewing window and copy the graph into your notebook file.*
- E3. Calculate the exact coordinates of the zeros of f , as well as their approximate values. Verify your answers in the graph.*
- E4. Factor the formula of $f(x)$. In factorized form you can recognize the zeroes as well. Explain how.*
- E5. The factorized form of $f(x)$ also reveals the vertical asymptote. Give the equation of this asymptote. How did you find it?*
- E6. Expand the formula of $f(x)$. In the expanded form, you can recognize the linear function, which represents the second asymptote of the graph of f . Explain how you can recognise the asymptote and add this asymptote to the graph.*
- E7. If we want to calculate the extreme values of f , we should find the derivative of f . Select the derivative command from the Math Calculus menu of the Math Palette. Complete the command as `derivative(f(x),x)`.*
- E8. Find the values of x for which the derivative is equal to zero, and calculate the exact and approximate coordinates of the extrema.*