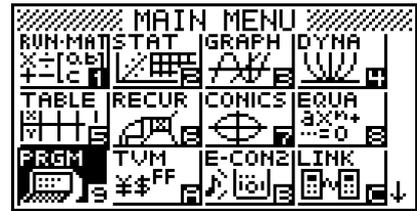# Peano Axioms and Programming

This resource was written by Derek Smith with the support of CASIO New Zealand. It may be freely distributed but remains the intellectual property of the author and CASIO.

Select the **PRGM** mode from the **MAIN MENU** by using the arrow keys to highlight the **PRGM** icon and press **[EXE]** or pressing **[9]**.

Peano axioms are a set of axioms for the natural numbers, presented by the 19th century Italian mathematician Giuseppe Peano.
The first set of axioms states the existence of at least one member of the set of natural numbers. The next are general statements about equality. The next set of axioms are called the first-order statements. These are about expressing the fundamental properties of the successor operation. The final axioms are the second-order statements, identified as the Principle of Mathematical Induction over the set of natural numbers.
The Peano axioms define the arithmetical properties of natural numbers, usually represented as the set **N**.
The first axiom states that 0 is a natural number.
The next set of axioms describe the equality relation:

- For every natural number x, $x = x$. That is, equality is reflexive, 'x maps onto itself'.
- For all natural numbers x and y, if $x = y$, then $y = x$. That is, equality is symmetric, 'if x implies y, then y implies x'.
- For all natural numbers x, y and z, if $x = y$ and $y = z$, then $x = z$. That is, equality is transitive, 'if x is related to y, and y is related to z, then x is related to z'.

The remaining axioms define the arithmetical properties of the natural numbers. The natural numbers are assumed to be closed under an operation system S., e.g. +, -, ×, ÷.
For every natural number n, then $S(n)$ is a natural number.
For all natural numbers m and n, then $m = n$ if and only if $S(m) = S(n)$.
If one wishes to prove a statement for all natural numbers then the proof by induction consists of:

1. Showing that it is true for S(0)
2. Showing that the statement is true holds when $n \leq k$.
3. Showing that if the statement holds for some $k + 1$, then the same statement also holds for $n + 1$.

[Source: https://en.wikipedia.org/wiki/Peano_axioms]

So, …let's try to count!
Enter into the **Program** mode from the **MAIN MENU**. If you have no programs listed on the calculator then you will see this screenshot below, otherwise you will see a list of programmes in numerical order, based on the naming conventions given to the programme) followed by programmes listed in alphabetical order.
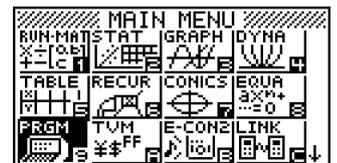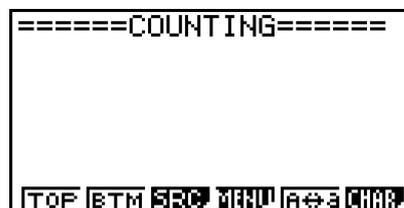
Press **[F3]** to crerate a new program.

You will be prompted to give te program a name.
Note that the keys on the calcualtor are locked to **[ALPHA]**
Here, so you can use the appropriate keys directly.

Example: Write a programme to display the Natural numbers (Counting) = {1, 2, 3, 4, 5, 6, ….}

Name the program '**COUNTING**'. Then press [**EXE**]. This will store the program, and as you write the code, the calculator automatically saves the program as it is written.

The tools for writing code (in the FX9750Gii, it is very similar to visual BASIC) are in **PRGM** found by pressing [**SHIFT**] [**VARS**].

In this program we will be using the 'print triangle' ◢ [**F5**], '**Lbl**' and '**Goto**' commands.

'**Lbl**' and '**Goto**' are found via **JUMP** [**F3**], then for **Lbl** press [**F1**] and for **Goto** press [**F2**]. The use of press '**Lbl**' and '**Goto**' form a loop or 'subroutine' that repeats itself over and over or until it is told to stop. **LBL** is the beginning of the loop and **Goto** is the end of the loop that takes you back to the start of the loop.

The → and ↵ are entered using the [→] and [**EXE**] keys respectively.

The → assigns a value to a variable and [**EXE**] crreates a line break (to start a new line of code).
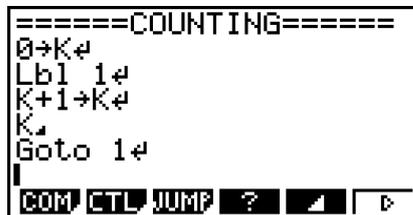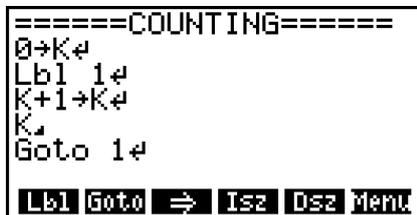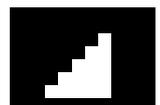

Here **0** is assigned to the variable **K**.

The loop now increments **K** by 1 and then prints the value of **K** to the screen, and this is repeated over and over again, each time [**EXE**] is pressed.

Now press [**EXIT**] twice and you should see the screenshot shown below. You will notice a number to the right of the program name. This tell you how many bytes were used to write the program, in this case 52 bytes.

To **RUN** the program **COUNTING**, press either the [**EXE**] or [**F1**] key.

Then press [**EXE**] repeatedly and you will display the Natural numbers (Counting) = {1, 2, 3, 4, 5, 6, ….}
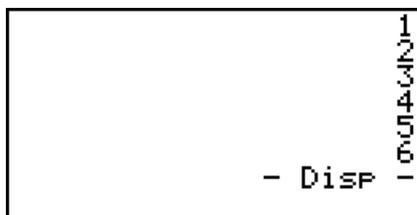
[Note: - Disp – is the calculators' way of saying that you can generate the next item of your program press [**EXE**]. To '**Break**' the program then press [**AC**] twice.

How could you modify this program to:
1. start at a specific number?
2. stop at a specific number?
3. start and stop at specific numbers?
4. display the odd numbers (or even numbers)?