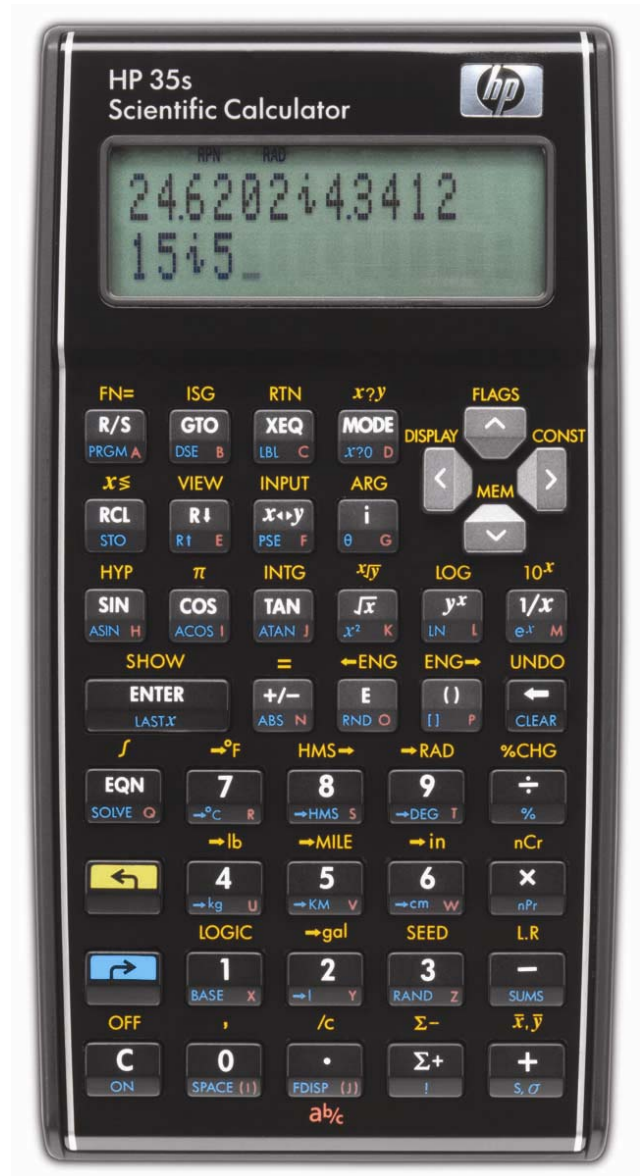hp calculators

HP 35s Writing a Simple Program

Programming the HP 35s

Practice example: the area of a circle

Tools for programming

HP 35s Writing a Simple Program

Programming the HP 35s

Doing a simple calculation once on the HP 35s is easy. Doing the same calculation many times, or doing a complicated calculation, takes longer. It can be better to store all the steps needed for the calculation in a **program**. A program is a set of instructions, stored all together. Once it is written, it can be tested to see if it works correctly. Then it can be used many times, without the need to press every key of the calculation each time.

A simple program is just a set of keystrokes stored so that they can be carried out with one key. The HP 35s provides many commands to let programs do more, for example stop and ask for input, or show an intermediate result. This training aid concentrates on simple programming; it also shows a few of the more advanced programming commands.

Practice example: the area of a circle

Given "r" the radius of a circle, the circle's area "A" is calculated from the formula $A = \pi r^2$. For example to calculate the area of a circle with radius 3cm, the following keys are pressed.

In RPN mode: $\boxed{3}$ $\boxed{\leftrightarrows}$ $\boxed{x^2}$ $\boxed{\leftarrow}$ $\boxed{\pi}$ $\boxed{\times}$

And in algebraic mode: $\boxed{\leftrightarrows}$ $\boxed{x^2}$ $\boxed{3}$ $\boxed{>}$ $\boxed{\times}$ $\boxed{\leftarrow}$ $\boxed{\pi}$ $\boxed{\text{ENTER}}$
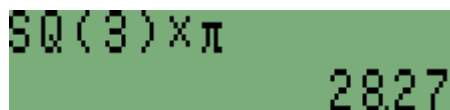

SQ(3)×π

28.27   Figure 1

Repeating the same 6 keys in RPN mode or 8 keys in algebraic mode for many circles is a lot of work. Here is how a program would make it easier.

Example 1:   Write a program in RPN mode to calculate the area of a circle, given its radius r.

Solution: An RPN program and an algebraic program are shown below. The RPN program is shown first, called "A" for "Area".

In RPN mode, type the same keys for calculating the area as before, but mark the beginning of the program with a **label** and the end of the program with a **return**.

First set program mode by typing $\boxed{\leftrightarrows}$ $\boxed{\text{PRGM}}$ and then go to the top of program memory (called PRGM TOP, see Figure 2), ready to begin a new program, by typing $\boxed{\text{GTO}}$ $\boxed{\cdot}$ $\boxed{\cdot}$. Now the program can be typed:

$\boxed{\leftrightarrows}$ $\boxed{\text{LBL}}$ $\boxed{A}$ $\boxed{\leftrightarrows}$ $\boxed{x^2}$ $\boxed{\leftarrow}$ $\boxed{\pi}$ $\boxed{\times}$ $\boxed{\leftarrow}$ $\boxed{\text{RTN}}$

The letter A is on the keyboard, below and to the right of the $\boxed{\text{R/S}}$ key. Whenever $\boxed{\text{LBL}}$ is typed, the HP 35s uses the keys with the letters A – Z marked next to them to enter those letters.

The program will look as shown in Figures 2 through 4 below.

```
PRGM TOP
A001 LBL A
```
Figure 2

```
A002 x²
A003 π
```
Figure 3

```
A004 ×
A005 RTN
```
Figure 4

Each line of the program begins with the letter of the label, and then has a four-digit line number. The rest of the program line is a function or a program instruction. The program instructions are LBL A and RTN, the functions are x^2, π and ×.

To use the program, it is necessary to move out of program mode, and to return to the beginning of the program. Then a radius is typed and the R/S key is pressed. The HP 35s executes (or runs) the program.

To calculate the area of a circle with radius 5, make sure RPN mode is set, then press:

[↱] [PRGM] [↰] [RTN] [5] [R/S]

```
28.27
78.54
```
Figure 5

Answer: The area of a circle with radius 5 cm is just over 78.54 square cm.

To calculate the area of another circle with a different radius, it is enough to type the new radius and press R/S again. The program works like a new function, executed by means of the R/S key instead of a key with the name of one of the functions built into the HP 35s.

Example 2:   Write a program in algebraic mode to calculate the area of a circle, given its radius r.

Solution: In algebraic mode, the program looks very similar, but with the calculation keys typed in algebraic order. The HP 35s does not allow more than one program to have the same label, so the algebraic program below is given the label B.

Go to the beginning of program memory by typing [GTO] [·] [·] and set program mode by typing [↱] [PRGM]. Then type the algebraic mode program:

[↱] [LBL] [B] [MODE] [4] [↱] [x²] [R↓] [‹] [ENTER] [×] [π] [ENTER] [↰] [RTN]

To get [B] press the [GTO] key; it has a small B to its lower right. The program lines are as listed below.

```
PRGM TOP
B001 LBL B
```
Figure 6

```
B002 ALG
B003 SQ(REGX)x
```
Figure 7

```
B002 ALG
03 SQ(REGX)xπ_
```
Figure 8

```
B003 SQ(REGX)…
B004 RTN
```
Figure 9

The second line is an instruction to set algebraic mode, to make sure program B is not used accidentally in RPN mode. If the user always works in algebraic mode, or always remembers to switch to the right mode before using a program then this program line is not needed, but it is always safer to use it. A similar line, setting RPN mode, could have been used in program A for the same reason.

Line B003 squares the value in the X register, referred to in the program as REGX. This value will be the value keyed in before the program is run.

This program works just like the RPN version. To use it, first move out of program mode, and to go to the beginning of the program. Then a radius is typed and the program is executed.

Therefore, to calculate the area of a circle with radius 5, press:

[→] [PRGM] [◄] [RTN] [5] [R/S]

```
                    78.54
```
Figure 10

Answer: As in RPN mode, the area of a circle with radius 5 cm is calculated at just over 78.54 square cm.

To calculate the area of another circle with a different radius, it is enough to type the new radius and press [R/S] again. Like the RPN program, this program works similarly to a new function, executed by means of the [R/S] key instead of a key with the name of one of the functions built into the HP 35s.

Tools for programming

The HP 35s allows the user to create any or all of the labels from LBL A through LBL Z. The lines after a label all have that label at the beginning of their line numbers. When a new label is typed, the HP 35s starts over again at line 1, with

the new label's name at the beginning of each line. Figure 7 shows an example of this; if both program A and program B were typed, then after the RTN in program B, the first line of program A is displayed on the calculator screen.

```
B005 RTN
A001 LBL A
```
Figure 11

Each label can be used only one time, and the HP 35s treats the lines from one label until the next label as a separate program. It is also possible to have a program with no label, from the "PRGM TOP" until the first label.

To list the programs in the HP 35s, press the keys ⬛ MEM to get the "Memory" menu, and then 2 to get a display of programs. If the algebraic version of the circle program has been entered then the calculator screen will look like Figure 12. If only program A was typed, the screen will be as in Figure 13.

```
LBL B
LN=25
```
Figure 12

This means that the program with label B is the first program in memory, and that it is 25 bytes long. A byte is a piece of calculator memory made up of 8 bits, and a bit is the smallest piece of memory, a single "0" or "1". The HP 35s has more than 29,000 bytes of memory available to hold programs and equations entered by the user. Given this much memory, a long program could have up to 999 program lines, and that is why program line numbers are 3 digits long. The up and down arrows at the right of the screen mean that there are more programs in the calculator – information about each program in turn is displayed if the up or down arrow keys are pressed. If both the programs A and B have been entered, press ⬛ to see information about program A.

```
LBL A
LN=15
```
Figure 13

Another tool to help in writing programs is the program checksum. To see the checksum for program A, press ⬛ SHOW . While the SHOW key is held down, the calculator will show:

```
CK=DAF1
LN=15
```
Figure 14

CK=DAF1means that the checksum for program A is the hexadecimal number DAF1. (The checksum for program B is AD0A.) If the program was not typed correctly, then the checksum will be different. Press the key labeled C at the bottom left of the keyboard to cancel the display of information about programs.

The checksum has several purposes:

- If a program is correctly copied to the HP 35s from a web page or a book – the HP 35s manual has many useful example programs – then the checksum on the HP 35s will be the same as the checksum given with the program. If the checksum is not the same, a mistake was made and the program should be checked and corrected before it is used.

- If a user creates a new program on an HP 35s and then writes it down for future use, it is worth keeping a note of the checksum with the written program. That way, the program can be checked if it is typed into the HP 35s again later.

- If a user wants to offer a program to other users, the checksum should be given with the program, so the other users can check if they have entered the program correctly into their HP 35s.

The checksum can be very helpful, but it does not have to be used – for short programs such as the above it can be enough to step through the program with the up and down arrow keys and correct any mistakes.

Mistakes can be either wrongly typed lines, or missing lines. To add a missing line, use the ⌃ and ⌄ keys until the line before the missing line is at the bottom of the screen. Then type the missing line or lines. If a line is wrong, move it to the lower line of the screen and use the ⟵ key to delete one or more lines, then type the correct line or lines.

Even after all typing errors have been corrected, a program can still be wrong if it was designed wrongly. The HP 35s manual provides advice on program testing and describes more programming tools.

To go to a line in a program, to see it or to change it, use the GTO command, followed by a dot and then the program name and the line number. For example to go to line 5 of program A type GTO · A 0 0 5.

The LBL and the RTN help to identify each program. If a program is executed by the user pressing R/S then the RTN goes back to the top of program memory, where the program stops. If both program B and program A are in the HP 35s, and program A is used, then the RTN at the end will go to label B at the top of program memory. Next time R/S is pressed, program B will begin, not program A. This means that only the program at the top of program memory will work like a function key when R/S is pressed. To execute program A if it is not at the top of memory, press XEQ A ENTER.