



hp calculators

HP 35s Using Register Arithmetic

Variables and Memory Registers

Practice Examples:

Calculating Using STO Arithmetic

Calculating Using RCL Arithmetic in RPN mode

Storage Arithmetic in a Program



Variables and Memory Registers

The purpose of this training aid is to show how arithmetic can be carried out directly using HP 35s memory registers. First, the following is a short explanation of variables and registers; the same information is given in the practice aid on using calculator memories. That training aid then gives more information on the various other uses of memory registers.

When an equation is typed on the HP 35s, it can use **variables** with names from A through Z. For example an equation

$$3X^2 - 5X = A$$

has the variables X and A in it.

Variables can also be used in programs and in calculations from the keyboard.

Each variable consists of a number and of a place in the calculator memory where the number is stored.

The number is called the **value** of the variable. If no value has been given to a variable then its value is 0.

The place in memory where this number is stored is called a **data register**, or a **memory register**, or just a **register**.

Each memory register can be referred to by a numeral as well as by its name. Register A is -1 and register Z is -26. Six more registers can be referred to by numerals, holding values from statistics calculations. The names "data register" or "memory register" or "memory" refer to all of these, not just the variables, so these names are sometimes used in this training aid, rather than the name "variables."

The training aid on general uses of registers shows that numbers can be stored in registers by the STO command, and can be recalled from registers by the RCL command. This aid covers the special topic of how arithmetic can be carried out directly with memory registers using the commands STO+, STO-, STO×, STO÷, RCL+, RCL-, RCL× and RCL÷ in RPN mode and also shows alternatives that can be used in algebraic mode.

Practice Example: Calculating Using STO Arithmetic

The HP 35s provides a set of physical constants, such as the speed of light. Users who need to store other constants can put them into the memory registers so they can be used in calculations.

Example 1: A planetary scientist needs to perform several calculations using the masses of the Earth and the Moon. First the scientist wants to store the mass of the Earth in register E and of the Moon in M, in kilograms. The Earth-Moon system is sometimes called a "twin planet system" and the scientist wants to put the total mass of the Earth and the Moon in register T.

Solution: First type the Moon's mass, then press **[⇨] [STO]** and the variable name to store the mass in that variable's memory register. Press the keys as shown below. The key labeled **[E]** is above the **[9]** on the keyboard. Typing **[E] [2] [2]** means "times 10 to the power 22".

[7] [.] [3] [4] [9] [E] [2] [2] [⇨] [STO] [M]

(Note: In algebraic mode, press **[ENTER]** after the **[M]** above)

When $\boxed{\rightarrow}$ $\boxed{\text{STO}}$ is pressed, the symbol "A..Z" appears at the top of the screen. This tells the user that the next key pressed should be one of the keys with letters A to Z at their lower right, and that the corresponding letter will be used. For the letter "M", press the $\boxed{\text{M}}$ key. The number is stored in M, but remains on the lower line of the screen, as shown in Figure 1 (which shows the display in algebraic mode).

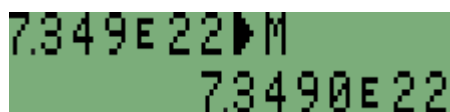


Figure 1

Store the Moon's mass in register T as well, so that the Earth's mass can be added to it. The mass has already been stored in M but it is still available to be stored in T as well. Figure 2 shows the screen in algebraic mode.

$\boxed{\rightarrow}$ $\boxed{\text{STO}}$ $\boxed{\text{T}}$ (Note: In algebraic mode, press $\boxed{\text{ENTER}}$ after the $\boxed{\text{T}}$)



Figure 2

Now type the mass of the Earth and store it in register E. To use register E, press $\boxed{\text{R}}$ when the A..Z symbol is at the top of the screen. This is **not** the same as the key labeled $\boxed{\text{E}}$ used for entering powers of 10.

$\boxed{5}$ $\boxed{\cdot}$ $\boxed{9}$ $\boxed{7}$ $\boxed{3}$ $\boxed{6}$ $\boxed{\text{E}}$ $\boxed{2}$ $\boxed{4}$ $\boxed{\rightarrow}$ $\boxed{\text{STO}}$ $\boxed{\text{E}}$

The mass of the Earth is now in register E and is still on the lower line of the screen. To add it to the mass of the Moon already in register T, use the STO+ command in RPN mode only.

$\boxed{\rightarrow}$ $\boxed{\text{STO}}$ $\boxed{+}$ $\boxed{\text{T}}$

In RPN mode, this takes the number in the lower line of the display and adds it to register T. The number is still available for further use. It is still the "current number", i.e., the number is still in stack register X. Figure 3 assumes RPN mode.



Figure 3

In algebraic mode, it is necessary to key the following to perform a STO+ equivalent. NOTE: The resulting value displayed is different in algebraic mode when compared to RPN mode. Figure 4 assumes algebraic mode.

$\boxed{+}$ $\boxed{\text{RCL}}$ $\boxed{\text{T}}$ $\boxed{\rightarrow}$ $\boxed{\text{STO}}$ $\boxed{\text{T}}$

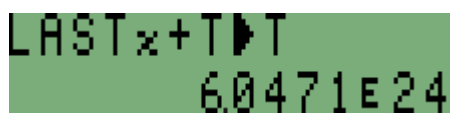


Figure 4

Answer: The mass of the Moon is now in register M, the mass of the Earth is in register E, and the mass of the Earth-Moon twin system is in register T. The mass of the Earth is also still in the current register, as shown in Figure 2. To confirm that the number in register T is the sum of the two masses, view register T by pressing:

 **VIEW** **T**



T = 6.0471E24

Figure 5

In RPN mode, the STO+ command adds the current number to the register selected by its name, STO- subtracts the current number from the named register, STO× multiplies the named register by the current number and STO÷ divides the named register by the current number. In all these cases in RPN mode, the number itself is unchanged and continues to be the current number. As it has not changed, the value in the LastX register also remains unchanged.

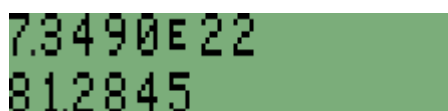
Practice Example: Calculating Using RCL Arithmetic in RPN mode

Example 2: If the Earth-Moon system is called a twin system, the mass of the Moon should be fairly similar to the mass of the Earth. How do they compare?

Solution: The mass of the Earth is still in the current register. Recall the mass of the Moon from register M and divide it into the current register. Press these keys.

RCL **÷** **M**

The result of the division is now in the current register.



7.3490E22
81.2845

Figure 6

Answer: The ratio of the masses of the Earth and the Moon is about 1:81. The Moon's mass is only about 1.2% that of the Earth's, not really a twin. Nevertheless, the two are much closer in mass than any other major planet-satellite system. For example the mass of Ganymede is 0.0078% of the mass of Jupiter, and the mass of Deimos is 0.0000017% of the mass of Mars. Only Charon and Pluto are closer, with Charon having about 15% of the mass of Pluto – and not all planetary scientists are willing to consider Pluto to be a planet.

In RPN mode, when **RCL** is pressed, followed by an arithmetic operation and a letter, then the number in the chosen register is recalled and added to, subtracted from, multiplied by, or divided into, the current register. As opposed to STO arithmetic, RCL arithmetic changes the current number and leaves the stored number unchanged. Because the current number is changed, its previous value is stored in the LastX register for re-use in RPN mode.

Storage Arithmetic in a Program

As these examples show, STO and RCL arithmetic make some calculations easier to carry out. It is generally quicker to use a STO or RCL arithmetic operation rather than to RCL a number, calculate with it, and then STO the result. Quite

apart from this, many users find that storage register arithmetic has important applications in programs. There are three reasons for this.

- (1) Each STO or RCL instruction takes one less step in a program than STO or RCL followed by a separate arithmetic command. Saving a step in a program makes it shorter, faster and easier to read.
- (2) STO arithmetic does not use the RPN stack and does not change the LastX register. This means that programs can be written to work in the same way as built-in HP 35s functions, to replace the original number with a calculated result, keep a copy of the original number in LastX, and leave the rest of the stack unchanged. Such programs can then be used like built-in functions, and can be called from other programs.

This training aid has shown how STO and RCL arithmetic can be useful in keyboard calculations and in programming. With experience, users can find many occasions where storage arithmetic on the HP 35s is a real help in their work.