



hp calculators

HP 33S Working with Fractions

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Simple Examples Using Fractions

The HP 33S allows the user to enter numbers as fractions of the form “a b/c”, to view results as fractions, and to control the way fractions are displayed. The symbol “a b/c” is written below the decimal point on the keyboard as a reminder that this key is used for most operations with fractions. Four simple examples will show the basics.

Example 1: Add $1\frac{3}{4}$ to $2\frac{5}{8}$

Solution: The decimal point is used for fraction entry as follows.

In RPN mode, type the number 1 and press the decimal point key to separate the fractional part from the integer part. Then type 3, and the calculator will display 1.3. Press the decimal point key again and the calculator will recognize that a fraction is being entered. Press the number 4 and the calculator will display the fraction, as in Figure 1.



Figure 1

Now press then press the **ENTER** key, then type the number $2\frac{5}{8}$ in the same way. Finally add the two. The keystrokes for the whole calculation are as below.

1 **.** **3** **.** **4** **ENTER** **2** **.** **5** **.** **8** **+**



Figure 2

In algebraic mode, enter the numbers in the same way, but press the plus key between the two numbers.

1 **.** **3** **.** **4** **+** **2** **.** **5** **.** **8** **ENTER**

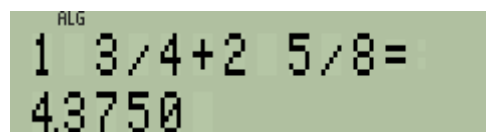


Figure 3

Answer: The result is $4\frac{3}{8}$ and is displayed as a decimal number; the HP 33S recognizes numbers that are entered as fractions, but displays numbers as decimals unless told to display them as fractions.

Example 2: Display the result of the above calculation as a fraction.

Solution: Both in RPN mode and in algebraic mode, press **FDISP** for fractional display of numbers.

FDISP

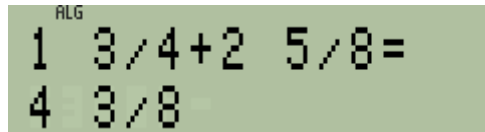


Figure 4

Answer: The result, $4 \frac{3}{8}$ is now displayed as a fraction; the display of Figure 3 will change to that in Figure 4. **[FDISP]** is above the decimal point key, which is also used for entering fractions.

Example 3: Display the result using only halves, thirds or quarters.

Solution: The **[D/C]** key allows the user to select the largest value allowable for the “c” part of a fraction “a b/c”. If the number 4 is stored in **[D/C]** then only fractions with 2, 3 or 4 on the lower part (the denominator) will be displayed.

In RPN mode, type 4 and then press **[RND]** **[D/C]** to see the previous result displayed as a fraction using only halves, thirds, or quarters.

[4] **[RND]** **[D/C]**



Figure 5

The number $4 \frac{3}{8}$ is displayed, rounded to $4 \frac{1}{3}$.

In algebraic mode, typing a new number after a previous calculation replaces the previous answer. Use **[LASTx]** to bring back the previous answer and see it in the new setting.

[4] **[RND]** **[D/C]** **[LASTx]**



Figure 6

Answer: If the fraction $\frac{3}{8}$ must be approximated as the nearest fraction with 2, 3 or 4 in the denominator, then the closest value is $\frac{1}{3}$. A small up-arrow symbol is shown at the right of the display, informing the user that the real answer is slightly larger than the answer displayed. The number $4 \frac{1}{3}$ is 4.3333333333 to the accuracy of the HP 33S, but the true number is $4 \frac{3}{8}$, or 4.375 exactly. To show the exact value, **[SHOW]** must be pressed. Like **[FDISP]**, **[D/C]** is above the decimal point key, which is also used for entering fractions.

Example 4: Round the actual result to be the result displayed.

Solution: As the example above showed, the value is not altered when the fraction display is changed. **[FDISP]** is a display mode, much like FIX or ENG, which also change the way a number is displayed, but not its true value. To change the true value to be as close as possible to that displayed, the RND (number round) command must be used.

In RPN mode or in algebraic mode, type $\boxed{\leftarrow} \boxed{\text{RND}}$ to round the result to the decimal representation of the fraction being displayed. Do not confuse $\boxed{\text{RND}}$ with the $\boxed{\text{RAND}}$ (random number) command.

$\boxed{\leftarrow} \boxed{\text{RND}}$

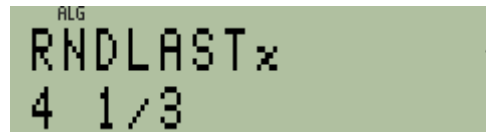


Figure 7

Answer: Pressing $\boxed{\rightarrow} \boxed{\text{SHOW}}$ shows that the decimal value has been rounded to 4.3333333333, which is the closest possible value to $4 \frac{1}{3}$.

The small arrow now points down, to show that the exact decimal value is smaller than the fraction displayed. This is because 4.3333333333 is just smaller than $4 \frac{1}{3}$.

To restore $\boxed{\text{C}}$ to its largest possible value, press $\boxed{0} \boxed{\rightarrow} \boxed{\text{C}}$. The largest possible value is 4095.

To stop showing numbers as fractions, press $\boxed{\leftarrow} \boxed{\text{FDISP}}$ a second time.

Entering and Using Fractions

As example 1 showed, pressing the decimal point key a second time during number entry tells the HP33C that a fraction is being entered. If the number to be entered is only a fraction, the decimal point key should be pressed twice after the top part of the fraction (the numerator) has been entered. The numerator can be larger than the denominator (this is called an improper fraction), so that fractions such as $4/3$ can be entered.

Example 5: Enter the fractions $5/17$ and $22/7$.

Solution: As is explained above, the user enters a fractional number with no integer part by pressing the decimal point *twice* after the numerator (the number on top) has been typed. In both RPN and algebraic modes, do this:

For $5/17$, type the following. The $\boxed{\text{ENTER}}$ key is used to separate this number from the next one.

$\boxed{5} \boxed{\cdot} \boxed{\cdot} \boxed{1} \boxed{7} \boxed{\text{ENTER}}$

For $22/7$, type

$\boxed{2} \boxed{2} \boxed{\cdot} \boxed{\cdot} \boxed{7}$



Figure 8

Answer: As can be seen in Figure 8, $5/17$ and $22/7$ are recognized as fractions.

Entry of a fraction cannot be combined with use of the **[E]** key to enter an exponent. The HP 33S allows at most 12 digits to be entered in the non-exponent part of a number (the mantissa), and this means that a number containing a fraction must not contain more than 12 digits, including the digits that make up the fraction.

Furthermore, the lower part of (the mantissa) a fraction must have no more than 4 digits. The mantissa is never displayed as a number larger than 4095, so a fraction such as $1/9100$ can be entered, but will be displayed as zero. Only leaving **[FDISP]** or using **[▶] [SHOW]** will show that the number is not truly zero.

Note: It is important to be aware that in fraction display mode a number that is displayed as zero might not truly be zero.

Fractions can be entered and displayed wherever ordinary decimal numbers can be used. For example fractions can be used in ordinary arithmetic, in calculations with logarithmic and trigonometric functions, and in complex numbers. Fractions cannot be used in binary, octal or hexadecimal modes, which all work just with integer numbers.

Fractions in Programs and Equations

When a program is being typed in, numbers can be typed as fractions, if the decimal point is pressed twice, but they will be displayed within the program as the equivalent decimal numbers.

When an equation is typed in, numbers cannot be typed as fractions. Instead, they should be typed using the division symbol. For example, $1\frac{1}{3}$ can be typed as $(1 + 1 \div 3)$. Better still is to type it as $4 \div 3$.

Example 6: Enter the equation $D + 1\frac{1}{3}$

Solution: As explained, $1\frac{1}{3}$ is best typed into an equation as $4/3$.

[▶] [EQN] [RCL] [D] [+] [4] [÷] [3] [ENTER]



Figure 9

Answer: The expression $D + 1\frac{1}{3}$ is entered as the equation $D + 4 \div 3$.

Note: the command **[FDISP]** cannot be stored in a program. Instead of this, flag 7 should be set to display fractions, and cleared to return to normal display of numbers. See below for information about flags.

Exact Control of Fraction Display

Example 4 showed that **[C]** can be used to control how fractions are displayed, through control of the denominator.

Normally, in **[FDISP]** mode, fractions are displayed to be as close as possible to the true value. The only limitation is that the denominator “c” can be no larger than 4095.

If a number smaller than 4095 is stored in **[C]** then the largest possible value of “c” is that number, but any possible value of “c” can be used.

If flag 8 is set, then the numerator must be exactly “c”, but the fraction can be simplified. If flag 8 is set and flag 9 is set too, then the numerator must be exactly “c”, and there is no simplification.

Example 7: Display the fraction 179/3000 using the different flag settings combined with $\frac{1}{c}$.

Solution: This example will be shown in RPN mode. The same steps work in algebraic mode, but that \leftarrow (LASTx) is needed after each step when a flag is changed, as in example 3 above. First enter the fraction, and make sure $\frac{1}{c}$ is set to 4095, which is its usual value.

$\boxed{1} \boxed{7} \boxed{9} \boxed{\cdot} \boxed{\cdot} \boxed{3} \boxed{0} \boxed{0} \boxed{0} \text{ENTER} \boxed{0} \boxed{\rightarrow} \boxed{\frac{1}{c}}$



Figure 10

179/3000 is displayed.

Now store 99 in $\frac{1}{c}$. This means that all fractions must be displayed with only one or two digits in the denominator.

$\boxed{9} \boxed{9} \boxed{\rightarrow} \boxed{\frac{1}{c}}$



Figure 11

The fraction is displayed with only two digits in the denominator, and it is rounded to the nearest possible fraction to 179/3000.

Now display the number with 99 as the denominator. To do this, set flag 8. First, select the flag menu:

$\boxed{\rightarrow} \boxed{\text{FLAGS}}$

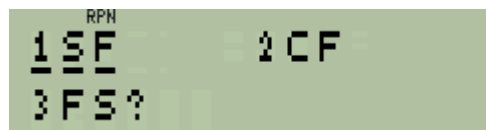


Figure 12

This brings up the flags menu. Press $\boxed{1}$ to select the SF (Set Flag) command. Then press $\boxed{8}$ to select flag 8.

$\boxed{1} \boxed{8}$



Figure 13

The result is now shown as 6/99 *but* this has been simplified to 2/33.

To display the fraction with the denominator exactly equal to 99, and no simplification, set flag 9 as well.

FLAGS **1** **9**

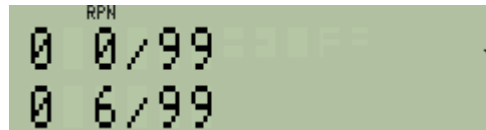


Figure 14

The result is now shown as 6/99 with no simplification.

Note: with flags 8 and 9 set to force all numbers to be displayed as multiples of 1/c, even zero is now displayed that way, so in Figure 14 the number 0 is shown as the fraction 0 0/99.

With flags 8 and 9 set, fractions will always be displayed as multiples of the denominator in . This can be very useful in some cases. For example, if a design is being drawn with a ruler marked in 1/16 of an inch, it is helpful to put 16 in , then set flags 8 and 9, and see the results of all calculations as multiples of one-sixteenth.

Finally, to return to the normal display, store 0 in , and clear flags 8 and 9. Clear flag 7 as well, to see that clearing flag 7 does the same as pressing **FDISP** to cancel fraction display mode.

0 **FLAGS** **2** **7** **FLAGS** **2** **8** **FLAGS** **2** **9**



Figure 15

Answer: When all the fraction settings are reset to normal, and flag 7 is cleared to cancel fraction display, the fraction 179/3000 is displayed as the decimal number 5.9666666667E-2.

Note: for more information about flags, see the training aid on flags.