hp calculators

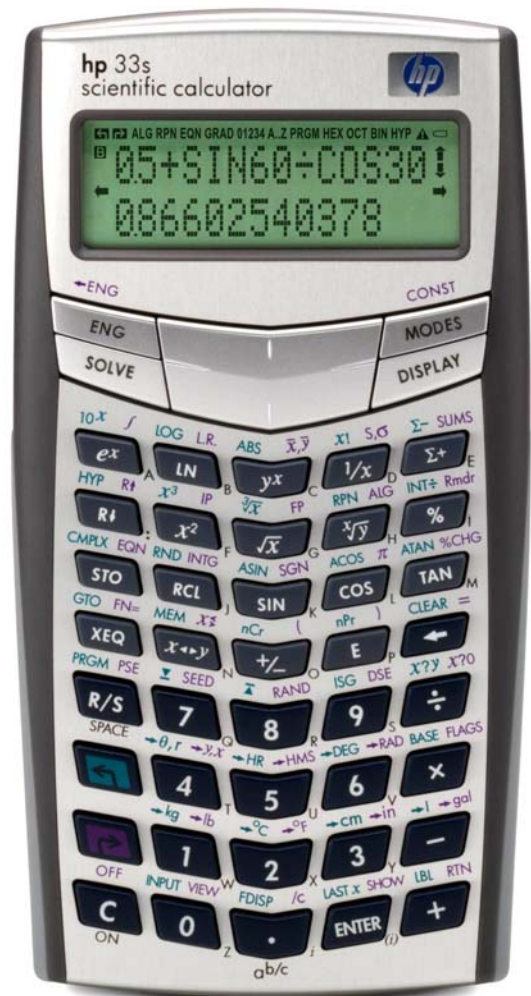**HP 33S** Unit Conversions

Metric units and Imperial units

Conversion keys

Practice working problems involving conversions

Performing conversions that are not built in

Equations and programs for complicated conversions

Special considerations for temperature conversions

Metric units and Imperial units

Measurements of quantities such as length, mass or temperature use units. Metric units include centimeters and meters, grams and kilograms, or Celsius and Kelvin degrees. Imperial units include feet and yards, ounces and pounds, or Fahrenheit and Rankine degrees. The HP 33S provides eight functions for converting to and from Metric units. These conversions are useful for many problems in engineering, mathematics, and physical and biological sciences. They can also be used to create additional conversions, through HP 33S equations and programs.

Two training aids describe unit conversions on the HP 33S. This aid describes mass, length and volume conversions. Temperature conversions are more complicated; a simple example is given in this training aid and a second training aid describes conversion of temperature units in detail. For coordinate, angle and time conversions see the separate training aids, for example angle conversions are covered in the training aid on angle conversions and angle arithmetic.

Conversion keys

The unit conversion functions are on the right and left shifted [1] [2] [3] and [−] keys. The available conversions are as follows:

> [◄] [→kg] for pounds to kilograms
> [►] [→lb] for kilograms to pounds
> [◄] [→°C] for Fahrenheit to Centigrade
> [►] [→°F] for Centigrade to Fahrenheit
> [◄] [→cm] for inches to centimeters
> [►] [→in] for centimeters to inches
> [◄] [→l] for gallons to liters, and
> [►] [→gal] for liters to gallons.

The right and left shifted functions on each key are the inverse of each other. Ways to build up other conversions from them are shown below.

Note that conversions *to* Metric units are always on the left-shifted leys, and conversions *from* Metric units are on the corresponding right-shifted keys.

Conversions of lb/kg, of in/cm, and of gal/l involve only multiplication by a conversion factor. Conversions of °F/°C require addition or subtraction of an offset constant as well as multiplication; they are described in more detail in the separate training aid on temperature conversions.

Practice working problems involving conversions

<u>Example 1:</u>   Convert 10 inches to centimeters

<u>Solution:</u>   In RPN mode, type the number 10 and then press the left-shifted [3] key.

[1] [0] [◄] [→cm]

In algebraic mode, do the same. Pressing [ENTER] completes the calculation, but this is not necessary unless the conversion is part of a longer calculation.

[1] [0] [◄] [→cm] [ENTER]

Figure 1

Answer: 25.4 centimeters.

Example 2: How many gallons is 25 liters?

Solution: In RPN mode, type the number 25 and then press the left-shifted ⊟ key.

2 5 🔁 →gal

In algebraic mode, do the same. Again, pressing ENTER completes the calculation, but is not necessary unless the conversion is part of a longer calculation.

2 5 🔁 →gal ENTER

Figure 2

Answer: 6.6043 gallons.

Example 3: Convert 16 square inches to square centimeters

Solution: A square inch is an inch times an inch. After one →cm conversion, the units become centimeters times inches. After a second →cm conversion, the units become centimeters times centimeters, or square centimeters. So, in this case, conversion to centimeters is carried out twice, to give square centimeters.

In RPN mode, type the number 16 and then press the left-shifted 3 key twice.

1 6 ◄ →cm ◄ →cm

In algebraic mode, do the same. Again, pressing ENTER completes the calculation, but is not necessary unless the conversion is part of a longer calculation.
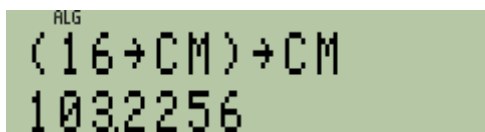
1 6 ◄ →cm ◄ →cm ENTER

Figure 3

Another way to do this is to take the square root of 16 cm², giving 4 cm, then convert this to inches, then take the square. Figure 4 shows the result and confirms that the method used above is correct.
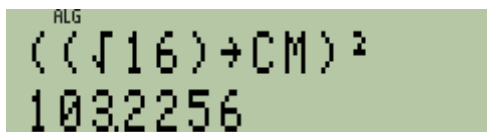
1 6 √x ◄ →cm x^2

Figure 4

Answer: 103.2256 square centimeters.

Example 4: Convert 5 yards to meters

Solution: The conversion keys use inches and centimeters, so it is necessary to go from yards to inches, then convert inches to centimeters, and finally go from centimeters to meters.

In RPN mode, type the number 5, multiply by 3 to go to feet, and multiply by 12 to go to inches. Now press the left-shifted ③ key to convert inches to centimeters. Finally divide by 100 to convert centimeters to meters.

⑤ ENTER ③ × ① ② × ◁ →cm ① ⓪ ⓪ ÷

In algebraic mode, the order is different, and ENTER must be used at the end to complete the whole calculation
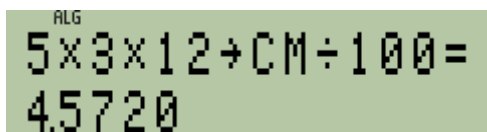
⑤ × ③ × ① ② ◁ →cm ÷ ① ⓪ ⓪ ENTER

Figure 5

Answer: 4.572 meters.

Performing conversions that are not built in

Example 5: As the density of water is 1 gm/cm³, what is it in lb/ft³ ?

Solution: This conversion is not built into the calculator. As in examples 3 and 4, it is therefore necessary to separate the calculation into the basic units, and then convert each unit. In this example, the steps required are:

- Convert gm to kg, by dividing by 1,000
- Convert kg to lb with →lb
- Convert 1/cm to 1/in three times, as the cm are cubed. A short cut for converting inverse units is to notice that this is the same as doing the opposite transformation. So, converting 1/cm to 1/in can be done with →cm.
- Convert 1/in³ to 1/ft³ by multiplying by 12 cubed.

In RPN mode, the above should be done with these keys:

① ENTER ① ⓪ ⓪ ⓪ ÷ ▷ →lb ◁ →cm ◁ →cm ◁ →cm ① ② ◁ x^3 ×

In algebraic mode, the following keys are used instead; note that ENTER is needed to complete the calculation.

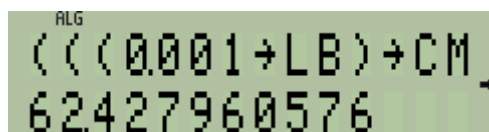① ÷ ① ⓪ ⓪ ⓪ ENTER ▷ →lb ◁ →cm ◁ →cm ◁ →cm × ① ② ◁ x^3 ENTER

Figure 6

Answer: The density of water is close to 62.4 pounds per cubic foot.

Equations and programs for complicated conversions

Example 6: The above is a complicated calculation to carry out. If a conversion like this is needed more than once, it is best to write a program or an equation to automate the conversion. Write an equation to convert gm/cm³ to lb/ft³, as above.

Solution: Assume that the density in gm/cm³ will be in the variable D. Then equation mode is entered by pressing ▣ EQN, and the expression is typed as follows:

▣ →lb ◀ →cm ◀ →cm ◀ →cm RCL D)))) × ◀ x³ 1 · 2) ENTER

Note that the division by 1000 can be combined with the multiplication by 12 cubed, into one multiplication by 1.2 cubed. The x-cubed function is displayed as CB(x) in equation mode.

The equation can be tested by pressing ENTER and seeing a prompt for the density D, as below.

Figure 7

1 R/S should be typed, and the equation will run for a moment, then the answer will be displayed. The equation can now be used again to convert a different density from gm/cm³ to lb/ft³; press ▣ EQN, to enter equation mode again, press ENTER to start the equation again, type the density, and press R/S to carry out the calculation.

Answer: The answer displayed is the same as the previous example: the density of water is close to 62.4 pounds per cubic foot.

Example 7: Use the equation from example 6 to convert the density of concrete (about 2400 kg/m³) to lb/ft³.

Solution: First divide by 1000 to convert 2400 kg/m³ to 2.4 gm/cm³. Then set equation mode and calculate the equation for D=2.4. If other equations are stored in the calculator, it might be necessary to use the up or down cursor keys to select the equation that was typed above.

▣ EQN ENTER

When the calculator asks for D, type:

2 · 4 R/S

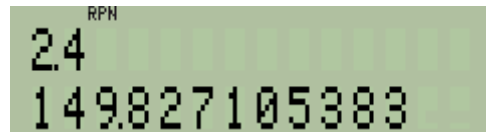In RPN mode the HP 33S would display this result.

Figure 8

<u>Answer:</u>   The density of concrete is close to 149.8 pounds per cubic foot.

Special considerations for temperature conversions

Special care must be taken with temperature conversions. The two commands →°C and →°F convert **temperatures** but not temperature differences. The following example shows a simple temperature conversion, for more details see the separate training aid on temperature conversions.

<u>Example 8:</u>   What is 20 degrees Celsius in Fahrenheit?

<u>Solution:</u>   In RPN mode, type the number 20 and then press the right-shifted 2 key.

2 0 ⏎ →°F

In algebraic mode, do the same. As usual, pressing ENTER completes the calculation, but is not necessary unless the conversion is part of a longer calculation.

2 0 ⏎ →°F ENTER

Figure 9

<u>Answer:</u>   68 degrees Fahrenheit.