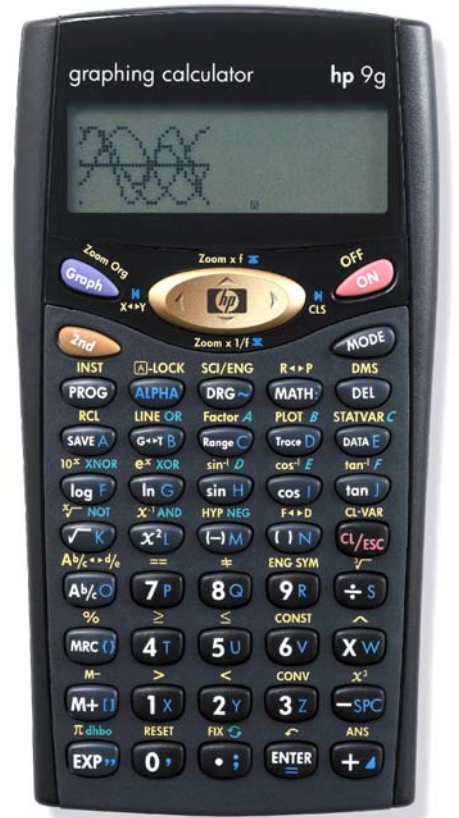# hp calculators

HP 9g Solving Problems Involving Unit Conversions

Metric Units and Imperial Units

The CONV Menu

Practice Working Problems Involving Conversions

Metric units and Imperial units

The Longman Mathematics Handbook (York Press, 1990) defines the unit as a conventional quantity that is used as a basis for *mensuration*, which is the study of giving numbers to quantities, that is to say, the act of measuring. There are two major system of units, namely the SI system (*Système International d'Unités*) and Imperial units. The latter are based on the pound and the yard, and, despite being replaced by the SI system, are still used in Britain and in the USA (with some differences). On the other hand, the SI system is a system based on these seven basic units: kilograms, meters, seconds, amperes, kelvins, moles and candelas. It is often referred to as the metric system, even though the SI system replaced this former system based on the meter and the gram. Metric units are therefore those based on the meter or belonging to a system of units that is based on the meter. Unit conversion is the change between two measurements of the *same* quantity in different units, and this task plays a lead role in science and engineering.

The CONV menu

The HP 9g provides seven menus of functions for converting to and from metric units. Pressing $\boxed{2nd}$ $\boxed{CONV}$ displays the first menu (length). In order to display the other menus, use the $\frown$ and $\smile$ keys or press $\boxed{2nd}$ $\boxed{CONV}$ again. Each menu contains several units, which can be selected by pressing the $\blacktriangleleft$ and $\blacktriangleright$ keys. Note that some menus consists of more units than the ones displayed initially (namely length, area and volume) – use the $\blacktriangleleft$ and $\blacktriangleright$ keys to display them. Except for temperatures ($°F = (9/5)°C + 32$), unit conversions involve a multiplication by a conversion factor. These are the 34 units available on your HP 9g, along with the corresponding value in SI units (except for temperatures again) used by the calculator.

Length		Area		Temperature	
feet	0.3048 m	ft^2	0.09290304000008 m^2	°F	−17.22222222222 °C
m	1 m	yd^2	0.8361273600008 m^2	°C	33.8 °F
mil	0.0000254 m	m^2	1 m^2		
mm	0.001 m	mile^2	2589988.110336 m^2		
in	0.0254 m	km^2	1000000 m^2		
cm	0.01 m	hectares	10000 m^2		
yd	0.9144000009144 m	acres	4046.8564224 m^2		
mile	1609.344 m				
km	1000 m				

Volume		Mass		Energy	
gal	3.785411784001E−3 m^3	Tr.oz	0.031103476800013 kg	J	1 J
liter	0.001 m^3	oz	0.028349523125 kg	cal.f	4.186800000009J
B.gal	4.546092000004E−3 m^3	lb	0.4535923772575 kg	**Pressure**	
Pint	0.473176473E−3 m^3	kg	1 kg	atm	101325 Pa
fl.oz	0.0295735295625E−3 m^3	g	0.001 kg	kPa	1000 Pa
				mmHg	133.322 Pa
				cmH20	98.0664999999 Pa

Some values are exact (e.g. feet, inch, gallon) while others are provided up to 13 digits of accuracy. On the HP 9g, °F and °C are used for converting temperature *measurements*, not temperature *differences* (see example below).

The CONV menu is only available in the MAIN and STAT operating modes. Particularly, note that the menus of unit conversions are not allowable in the PROG mode, and therefore these functions are *not* programmable.

Unlike physics constants ($\widehat{2nd}$ $\underline{CONST}$) which can be inserted into the entry line and be part of a calculation, unit conversions can only occur within the CONV menu, but results can be retrieved by the $\boxed{ENTER}$ key and are also stored in ANS. The following examples show the way of converting units using this menu, as well as ways of building up other conversions from the built-in units.

Practice working problems involving conversions

<u>Example 1:</u> Convert 21 yards to meters.

<u>Solution:</u> First of all, the quantity to be converted must be either keyed in into the entry line or already present in the result line, as the result of a previous calculation. Press $\boxed{2Y}$ $\boxed{1X}$. The $\boxed{ENTER}$ key is not necessary. Now display the CONV menu by pressing $\widehat{2nd}$ $\underline{CONV}$, the length menu is displayed. Now, we have to select the unit in which the input quantity is expressed; in our case, we have to select yards. Press $\blacktriangledown$ $\blacktriangledown$ $\blacktriangleright$ to select "yd" (which will appear underlined). The next step is to press $\boxed{ENTER}$. The quantity appears in the result line and the selected unit appears underlined. To convert that value, just select the desired unit by pressing the $\blacktriangleleft$, $\blacktriangleright$, $\blacktriangle$ and $\blacktriangledown$ keys. As the selected unit changes, the number in the result line changes accordingly. In this example, we need to find the number of meters corresponding to 21 yards. So press $\blacktriangle$ $\blacktriangle$ $\blacktriangleright$ and the result will appear in the result line.

<u>Answer:</u> 19.20240002 m.

<u>Example 2:</u> Add 12.5 meters to 21 yards. Express the result in feet.

<u>Solution:</u> All numbers in the result line are stored in the ANS variable and can be retrieved by the ANS function ($\widehat{2nd}$ $\underline{ANS}$). Remember also that ANS is automatically placed in the entry line by two-argument functions if no first argument is supplied. Therefore, since 21 yards expressed in meters are already in the result line from the previous example, to add 12.5 meters we just have to press:

$\boxed{+}$ $\boxed{1X}$ $\boxed{2Y}$ $\boxed{\cdot}$ $\boxed{5U}$ $\boxed{ENTER}$

31.70240002 is displayed in the result line. This quantity is expressed in meters, to convert it to feet press:

$\widehat{2nd}$ $\underline{CONV}$ $\blacktriangleright$ $\boxed{ENTER}$ $\blacktriangleleft$

In this case, the amount to be converted is the result of a previous calculation.

<u>Answer:</u> 104.0104988 feet.

<u>Example 3:</u> How many gallons is 25 liters?

<u>Solution:</u> First, enter the quantity in liters: $\boxed{2Y}$ $\boxed{5U}$. We have to work in the volume menu this time. To display it, press: $\widehat{2nd}$ $\underline{CONV}$ $\blacktriangle$ $\blacktriangle$ $\blacktriangle$ $\blacktriangle$. Once in the proper menu, select "liter" because this is the unit in which the entered quantity 25 is expressed, press $\blacktriangleright$ to underline "liter". Now press $\boxed{ENTER}$ to start the conversion, and select "gal" by pressing $\blacktriangleleft$. The answer appears in the result line. Remember that you can now press $\boxed{ENTER}$ to put this number in the entry line or $\boxed{CL/ESC}$ to start a new calculation.

<u>Answer:</u> 6.604301309 gal.

Example 4:   How many cubic inches is 1 gallon?

Solution: The cubic inch is not a built-in unit, but gallons can be easily converted to cubic inches if we remember that there are 1000 cm^3 in one liter. These are the calculations involved in this conversion:

$$1 \text{ gallon} = 1 \text{ gallon} \times \frac{3.785411784001 \text{ liters}}{1 \text{ gallon}} \times \frac{1000 \text{ cm}^3}{1 \text{ liter}} \times \frac{(0.3937007874016 \text{ inches})^3}{(1 \text{ cm})^3} = 231 \text{ inches}^3$$

The gallon→liter and cm→inch conversion factors are provided by the HP 9g. When ⏎ is pressed to put the result of a conversion into the entry line, it is the full-precision number that is retrieved, which means that the number in the entry line usually has more decimal digits than the number displayed in the result line, which is limited to ten digits.

Let's evaluate the above expression in two parts. First find how many cm^3 is 1 gallon and store this value into the variable C.

1 X   2nd CONV ∧ ∧ ∧ ∧ ENTER ❯ ENTER XW 1 X 0, 0, 0, SAVE A RangeC ENTER

Now we can complete the conversion multiplying C by the number of cubic inches in one cm^3 :

1 X   2nd CONV ∨ ∨ ENTER ❰ ENTER 2nd X³ ALPHA RangeC ENTER

Answer: 231 in^3 . Notice that this is an *exact* value, the origin of which is probably a 3 in × 7 in × 11 in rectangular block .

Example 5:   Convert 16 square inches into square centimeters.

Solution: In the above example we solved a similar exercise (cm^3 to in^3), but we'll carry out this conversion using another approach. A square inch is an inch times an inch. After one inch→cm conversion, the units become centimeters times inches. After a second inch→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:

1 X   6 V   2nd CONV ∨ ❯ ENTER ∨ ENTER

Notice that we must press ⏎ after the first conversion to put the result of the first conversion (40.64) in the entry line, so that the second conversion can use this quantity as an input:

2nd CONV ∨ ❯ ENTER ∨

Let's confirm that this result is correct by doing the following calculation:

$$16 \text{ inches}^2 = 16 \times 1 \text{ inch}^2 \times \frac{(2.54 \text{ cm})^2}{(1 \text{ inch})^2}$$

where the quantity 2.54 is provided by the HP 9g doing:

1 X 2nd CONV ⌄ ⟩ ENTER ⌄ ENTER

Once this conversion factor is in the entry line, we have to take the square and multiply by 16:

x^2 L 1 X 6 V

We obtain the same result, which confirms that the method used above is correct.

Answer: 103.2256 in^2

Special care must be taken with temperature conversions. Temperature conversions on the HP 9g are based on temperature *levels*. This preserves mathematical commutativity of addition, but does not always match engineering needs. Engineers often distinguish between a point on a temperature scale (degree Fahrenheit) and a distance (or *difference*) along that scale (Fahrenheit degree). A temperature level of 0ºC means "freezing," but a temperature difference of 0ºC means "no change." The following examples try to illustrate this difference.

Example 6: The HP-67 programmable pocket calculator was designed to retain the contents of its memory at temperatures as low as –40ºC. What is –40 degrees Celsius in Fahrenheit?

Solution: This conversion can be solved by the CONV menu:

⊖M 4 T 0 , 2nd CONV ⌃ ⌃ ⌃ ⌃ ⌃ ⟩ ENTER ⟨

Answer: –40ºF. That is not an error—this example shows that at –40 degrees the Celsius and Fahrenheit scales coincide.

Example 7: Determine if 25ºC is greater than 75ºF.

Solution: This is another example of temperature levels. Let's convert the latter to Celsius, by pressing:

7 P 5 U 2nd CONV ⌃ ⌃ ⌃ ⌃ ⌃ ENTER ⟩

Answer: 75ºF is 23.89ºC, therefore 25ºC is greater than 75ºF.

Example 8: An experimental new heater is designed to raise the temperature of its surroundings by exactly 20 Celsius degrees and then to turn itself off. If the heater is working correctly, what should the temperature be, in degrees Fahrenheit, after the heater is used in a room initially at a temperature of 50 degrees Fahrenheit?

Solution: A temperature *difference* of 20 Celsius degrees is not the same as a temperature of 20 degrees Celsius. A temperature of 20 degrees Celsius is 68 degrees Fahrenheit :

2 Y 0 , 2nd CONV ⌃ ⌃ ⌃ ⌃ ⌃ ⟩ ENTER ⟨

The temperature difference can be calculated as 20 *times 9 divided by 5*, giving 36 Fahrenheit degrees. Adding this to 50 will give 86 degrees Fahrenheit:

2ʸ 0ᐟ Xᵂ 9ᴿ ÷ˢ 5ᵁ +↵ 5ᵁ 0ᐟ Ⓔⁿᵀᴱᴿ

Alternatively, the conversion functions can be used to calculate this as follows. First of all, do the conversion 50ºF→ºC then add 20 and finally convert the result back to Fahrenheit:

5ᵁ 0ᐟ 2nd CONV ⌃ ⌃ ⌃ ⌃ ⌃ Ⓔⁿᵀᴱᴿ 〉 Ⓔⁿᵀᴱᴿ +↵ 2ʸ 0ᐟ 2nd CONV ⌃ ⌃ ⌃ ⌃ ⌃ 〉 Ⓔⁿᵀᴱᴿ 〈

Notice that completing the addition by pressing Ⓔⁿᵀᴱᴿ is not necessary because the functions of the CONV menu take their arguments *evaluating* the entry line (or from the result line if it is present).

Answer: 86 degrees Fahrenheit.