hp calculators

HP 9s Solving Problems Involving Unit Conversions

Metric Units and Imperial Units

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Practice Working Problems Involving Conversions

Metric units and Imperial units

In the Longman Mathematics Handbook (York Press, 1990) the unit is defined 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.

Unit conversions on the HP 9s

The HP 9s provides six functions for converting to and from metric units, namely in↔cm ($\boxed{2ndF}$ $\underline{in-cm}$), gal↔l ($\boxed{2ndF}$ $\underline{gal-l}$), ºF↔ºC ($\boxed{2ndF}$ $\underline{ºF-ºC}$), lb↔kg ($\boxed{2ndF}$ $\underline{lb-kg}$), mmHg↔kpa ($\boxed{2ndF}$ $\underline{mrn-kpa}$) and oz↔g ($\boxed{2ndF}$ $\underline{oz-g}$). All these functions are also available in STAT and CPLX modes. The direction of the conversion (e.g. whether the conversion is in→cm or cm→in) is determined by pressing either $\boxed{A-B}$ or $\boxed{2ndF}$ $\underline{A-B}$ first. The unit conversion functions are postfix functions, which means that their argument is the number currently being displayed. Except for temperatures (ºF↔ºC is used for converting temperature *measurements*, not temperature *differences* – see the example below), unit conversions involve a multiplication by a conversion factor. The following table shows the conversion factors used by the HP 9s; exact values are marked with an asterisk.

Length:	1 inch = 2.54 centimeters *
Volume:	1 gallon = 3.785411784 liters *
Temperature:	Fahrenheit = 1.8·Celsius + 32 *
Pressure:	1 mmHg = 0.1333224 kilopascals
Mass {	1 pound = 0.45359237 kilograms *
	1 ounce = 28.349523125 grams

The following examples illustrate the way of converting units using these functions, as well as some ways of building up other conversions from the built-in units.

Practice working problems involving conversions

<u>Example 1:</u>　Convert 21 inches into centimeters.

<u>Solution:</u>　First of all, the quantity to be converted must be either keyed in or already present in the display as the result of a calculation. The desired conversion function is in↔cm. Since we want to convert from inches to centimeters (in→cm), we must press $\boxed{A-B}$ just before pressing $\boxed{2ndF}$ $\underline{in-cm}$:

　　　　$\boxed{2}$ $\boxed{1}$ $\boxed{A-B}$ $\boxed{2ndF}$ $\underline{in-cm}$

　　　　Remember that the unit conversion keys must always be preceded by either $\boxed{A-B}$ or $\boxed{2ndF}$ $\underline{A-B}$.

<u>Answer:</u>　　53.34 cm

Example 2: Add 12.5 centimeters to 21 inches. Express the result in feet.

Solution: As 21 yards expressed in meters are already in the display, from the previous example, to add 12.5 centimeters simply press:

(+) (1) (2) (•) (5) (ENTER)

which results in 65.84. This quantity is expressed in meters. If we want to convert it into feet we need to know the following conversion factor, because the foot is not one of the built-in units: 1 foot = 30.48 cm The answer is then given by: (÷) (3) (0) (•) (4) (8) (ENTER) . But, you'll probably find it easier to remember that 1 foot = 12 inches. If so, convert the result (65.84) into inches and divide by 12:

(2ndF) A→B (2ndF) in→cm (÷) (1) (2) (ENTER)

Answer: 2.160104987 feet.

Example 3: How many gallons is 25 liters?

Solution: This is a built-in conversion, so simply press:

(2) (5) (2ndF) A→B (2ndF) gal→l

Answer: 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:

$$1\text{ gallon} = 1\text{ gallon} \times \frac{3.785411784\text{ liters}}{1\text{ gallon}} \times \frac{1000\text{ cm}^3}{1\text{ liter}} \times \frac{(0.393700787402\text{ inches})^3}{(1\text{ cm})^3} = 231\text{ inches}^3$$

The gallon→liter and cm→inch conversion factors are provided by the HP 9s:

(1) (0) (0) (0) (x) (1) (A→B) (2ndF) gal→l (x) (1) (2ndF) A→B (2ndF) in→cm (x^y) (3) (ENTER)

Answer: 231 in^3 . Note 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) (6) (A–B) (2ndF) in–cm (A–B) (2ndF) in–cm

Note that the result of the first conversion is the input of the second one.

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 9s doing:

(1) (A–B) (2ndF) in–cm

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

(x^2) (X) (1) (6) (ENTER)

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 9s 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 ºF↔ºC function:

(4) (0) (+/–) (A–B) (2ndF) ºF–ºC

Answer: –40ºF. That is not an error—this example shows that at –40 degrees the Celsius and Fahrenheit scales coincide.[1]

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) (5) (A–B) (2ndF) ºF–ºC

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

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[1] Temp. Fahrenheit = 1.8·Temp. Celsius + 32. Therefore, Temp. Fahrenheit = Temp. Celsius = T when T = 1.8·T + 32 $\Rightarrow$
T = 32 / (1 – 1.8) = – 40.

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 0 2ndF A–B 2ndF °F−°C

The temperature difference can be calculated as 20 *times 1.8*, giving 36 Fahrenheit degrees. Adding this to 50 will give 86 degrees Fahrenheit:

2 0 x 1 . 8 + 5 0 ENTER

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:

5 0 A–B 2ndF °F−°C + 2 0 ENTER 2ndF A–B 2ndF °F−°C

Notice that the ENTER key is necessary because it is the result of the addition, and not 20, that must be converted into Fahrenheit.

Answer: 86 degrees Fahrenheit.