hp calculators

HP 9s Base Conversions and Arithmetic

Numbers in Different Bases

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Practice Working with Numbers in Different Bases

Numbers in different bases

Our number system (called Hindu-Arabic) is a *decimal* system (it's also sometimes referred to as denary system) because it counts in 10s and powers of 10. Its base (i.e. the number on which the number system is built), is therefore 10. While base 10 numbers are extensively used, this is not the only possible base. There have been number systems with base 20 (used by the Mayas), mixed bases of 10 and 60 (used by the Babylonians), of 5 and 10 (ancient Romans), etc. Even nowadays the sexagesimal system (base 60) is used in some measurements of time and angle. The HP 9s enables you to work with numbers that are expressed in base 2, base 8, base 10 and base 16 numbers. All these bases are important in computing. Base 2 numbers are called binary numbers and their digits are limited to 1 and 0. A common abbreviation of binary digit is bit, which is either 1 or 0. Base 8 are called octal numbers, whose digits are 0, 1, 2, 3, 4, 5, 6 and 7. Finally, base 16 numbers are called hexadecimal numbers: 0, 1, 2, ,3 ,4 ,5 ,6 ,7 ,8 ,9, A, B, C, D, E and F.

The main difference between all these numbers is the value a digit have because of its place in a numeral. For example, in the decimal number 378 the digit 3 has value 300, 7 has value 70 and 8 has value 8. In other words:

$$378 = 3 \cdot 10^2 + 7 \cdot 10^1 + 8 \cdot 10^0$$

But if 378 were a hexadecimal number then its decimal value would be:

$$378\text{h} = 3 \cdot 16^2 + 7 \cdot 16^1 + 8 \cdot 16^0 = 888\text{d}$$

A small h, b, d and o after or before a number mean that this number is expressed in hexadecimal, binary, decimal or octal base respectively.

The binary, octal and hexadecimal modes

In addition to the normal operating mode, in which numbers are expressed in decimal base, the HP 9s has three special operating modes in which binary, hexadecimal, octal and decimal operations and conversions are performed. Press [2ndF] [→BIN] , [2ndF] [→OCT] or [2ndF] [→HEX] to set the desired mode: the number currently displayed is converted into the specified base. Bear in mind that only those digits allowable in the current mode can be entered: for example 102 is an invalid number in binary mode. Press [2ndF] [→DEC] to return to the normal decimal mode.

Not all the functions on the keyboard are available in the binary, octal and hexadecimal modes. Valid operations are the basic arithmetic ([+] , [−] , [x] , [÷]), parentheses and the memory keys. Note that the [•] key is disabled in these modes, which means that all arguments (and results) are integers.

Practice working with numbers in different bases

<u>Example 1:</u> Enter the hexadecimal number F9014 and convert it to decimal.

<u>Solution:</u> First let's set the calculator to hexadecimal mode by pressing [2ndF] [→HEX] . Note that the HEX annunciator is lit. In HEX mode, digits A through F are keyed in by pressing the keys [EXP] , [x^y] , [√] , [°'"] , [ln] and [log] , respectively. The [2ndF] key is not necessary:

[10^x F] (i.e. [log]) [9] [0] [1] [4]

To convert this number into decimal, simple press [2ndF] [→DEC] , which leaves HEX mode.

Answer: 1019924

Example 2: Convert the number in example 1 into octal base.

Solution: 2ndF →OCT . The current base is now octal.

Answer: 3710024o.

Example 3: Express the decimal number –340 in base 2.

Solution: If we try to display the previous number (1019924d) in base 2 (2ndF →BIN) we'll get an error, because that number is outside the allowable input range of BIN mode (where numbers are limited to 10 digits). The valid range is –512d through 511d. To express –340 in base 2, first let's input –340 in decimal mode:

2ndF →DEC 3 4 0 +/–

and now simply press: 2ndF →BIN , which modifies the current base mode.

Answer: 1010101100b.

Example 4: Add 7F6 base 16 to 1011001 base 2 and display the result in base 8.

Solution: Since base 2 has already been set in the previous example, let's start keying in the binary number:

1 0 1 1 0 0 1 +

7F6 must be enter in HEX mode, so press:

2ndF →HEX 7 10^x F (i.e. log) 6 ENTER

The sum is shown in HEX mode, to display it in base 8 press:

2ndF →OCT

Note that changing the current base does not cancel any pending arithmetic operation!

Answer: 4117 in base 8.

Example 5: Multiply the previous answer by ABCh. Express the result in base 10.

Solution: x 2ndF →HEX π A $\sqrt[x]{\ }$ B $\sqrt[3]{\ }$ C (i.e. EXP x^y $\sqrt{\ }$) ENTER 2ndF →DEC

Answer: 5844996 base 10.

Example 6: Which of the following numbers is the greatest? 473d, 712o, 1D8h and 110101000b

Solution: Let's input the first number, which is in decimal base: [2ndF] [→DEC] [4] [7] [3] . Let's change its base. Pressing [2ndF] [→OCT] results in 731o which is greater than 712º, and [2ndF] [→HEX] returns 1D9h, which is also greater than 1D8h. Thus far, 473 is the maximum. Let's press [2ndF] [→BIN] . The displays now reads

111011001, which is once again greater than the given number in base 2. If you prefer not to count bits, just press: [1] [1] [0] [1] [0] [1] [0] [0] [0] [2ndF] [→DEC] , which returns 424d.

Answer: d473.

Example 7: Subtract 42 base 8 from 101111 base 2 and then display the two's complement of the result in base 2.

Solution: The calculation in question is:

NEG(b101111 – o42)

where NEG is the change sign function ([+/–]) and calculates the two's complement of the argument (i.e. complements each bit and adds one).

[2ndF] [→BIN] [1] [0] [1] [1] [1] [1] [–] [2ndF] [→OCT] [4] [2] [2ndF] [→BIN] [ENTER] [+/–]

Answer: 1111110011 base 2. This is equivalent to –13 in base 10.