hp calculators

HP 30S Using the Built-in Physical Constants

The CONST Menu

Practice Solving Problems Involving Physical Constants

The CONST menu

The HP 30S provides twelve physics constants that can be used in calculations and included in your programs. All the constants are expressed in SI units, but only the values are present. For example, for the speed of light, the built-in value is 299792458 which is in m/s, even though the units are not stated.

For your convenience, the following table lists all the constants in the order they appear in the CONST menu, along with the keystroke sequence to copy their values into the entry line:

Symbol	Meaning	Value	Keys
c	Speed of light	299792458	[CONST] [ENTER]
g	Acceleration of gravity	9.80665	[CONST] ► [ENTER]
G	Gravitational constant	6.673e-11	[CONST] ► ► [ENTER]
Vm	Molar volume of ideal gas	0.022413996	[CONST] ► ► ► [ENTER]
Na	Avogadro's number	6.02214199e23	[CONST] ► ► ► ► [ENTER]
e	Elementary charge	1.602176462e-19	[CONST] ► ► ► ► ► [ENTER]
me	Electron mass	9.10938188e-31	[CONST] ► ► ► ► ► ► [ENTER]
mP	Proton mass	1.67262158e-27	[CONST] ◄ ◄ ◄ ◄ ◄ [ENTER]
mn	Neutron mass	1.67492716e-27	[CONST] ◄ ◄ ◄ ◄ [ENTER]
R	Gas constant	8.314472	[CONST] ◄ ◄ ◄ [ENTER]
h	Planck's constant	6.62606876e-34	[CONST] ◄ ◄ [ENTER]
k	Boltzmann's constant	1.3806503e-23	[CONST] ◄ [ENTER]

The CONST menu is displayed by the [CONST] key. It consists of three menus that display five, four and three constants each. You can use the arrow keys to scroll through the menus and select the desired constant. Once selected press [ENTER] to insert that constant in the entry line, at the current cursor position. Alternatively, press the next key if it is a function key, e.g.: [CONST] ► [x²] enters 9.80665^2 . Note that it is the value that is placed in the entry line, not the name. Also, the shortest keystroke sequences are shown in the above table. In order to exit the CONST menu without retrieving any constant value, simply press [CL] , which won't clear the entry line.

The HP 30S constants are available in all the operating modes.

Practice solving problems involving physical constants

Example 1: Find Plank's constant and view its full value.

Solution: Plank's constant, named "h" in the HP 30S, is in the second submenu of CONST, so the shortest way to *view* this value is to press the keys:

[CONST] ◄ ◄

If you want to invoke this constant in the entry line, press [ENTER] now that it is selected. To view Plank's constant in the result line, simply press [ENTER] again.

Answer: $6.62606876 \times 10^{-34}$

Example 2: Find the quotient between the proton mass and the electron mass.

Solution: This ratio is one of the built-in constants on the HP48GX and the HP49G+ and is called "mpme." Although it's not in the above list, you can calculate its value by pressing:

CONST ◄ ◄ ◄ ◄ ◄ ÷ CONST ► ► ► ► ► ► ENTER ENTER

Answer: mP/me = 1836.152663. Compare it with the value on the HP 48GX (1836.152701) and the one calculated on the HP 33S (1836.1526633). Greater accuracy in measures implies new standard values. Constants are not that constant after all!

Example 3: Einstein observed that any change in mass implies a change in energy and vice versa. Calculate the energy change corresponding to a change in mass of 1Kg.

Solution: Einstein's most famous equation states that:

$$\Delta E = \Delta m \cdot c^2$$

c is the speed of the light in the free space, and we can use the value built in our calculator. Since the change of mass is 1 in this example, the problem is reduced to squaring c. Press:

CONST x^2 ENTER

Answer: $8.987551787 \cdot 10^{16}$ J

Example 4: A cylindrical tank contains 4 kg of carbon monoxide at –50ºC (223K). The tank is 1 meter in length and its inner diameter is 0.2 m. Calculate the pressure of the gas using Van de Waals' equation.

Solution: This equation explains derivations from ideal gas behavior and is:

$$(P + \frac{a}{V^2})(V - b) = RT$$

where a and b are constants characteristics of a particular gas; for the carbon monoxide they are 0.1474 and $3.95 \cdot 10^{-5}$ respectively. Solving for P:

$$P = \frac{RT}{V - b} - \frac{a}{V^2}$$

Before starting to calculate, notice that V is actually the molar volume and, when expressed in m^3, is equal to:

$$V = \frac{7}{4000} \pi \cdot 0.2^2$$

Since it occurs twice in the pressure equation, we'll calculate this value first and use the ANS function to retrieve V. Press:

[.] [2] [x^2] [π] [7] [÷] [4] [E] [3] [ENTER]

and now we can calculate P by pressing:

[CONST] ◀ ◀ ◀ [×] [2] [2] [3] [÷] [(] [2nd] ANS [−] [3] [.] [9] [5] [E] [+/−] [5] [)] [−] [.] [1] [4] [7] [4] [÷] [2nd] ANS [x^2] [ENTER]

Answer: 7229306.314 Pa or 72.3 bar.

Example 5: Find the revolution period of an artificial satellite put into circular orbit around the Earth. The radius of the orbit is 8000 km.

Solution: The period is given by:

$$T = 2\pi\sqrt{\frac{R^3}{GM}}$$

where R is the radius of the orbit, M is the mass of the Earth ($5.98 \cdot 10^{24}$ kg) and G is the gravitational constant. (Note that it does *not* depend on the mass of the satellite). The period can be calculated as follows:

[2] [π] [√] [8] [E] [6] [2nd] y^x [3] [÷] [(] [CONST] ▶ ▶ [ENTER] [×] [5] [.] [9] [8] [E] [2] [4] [ENTER]

Answer: 7117.110266 s or 2 hours approximately.