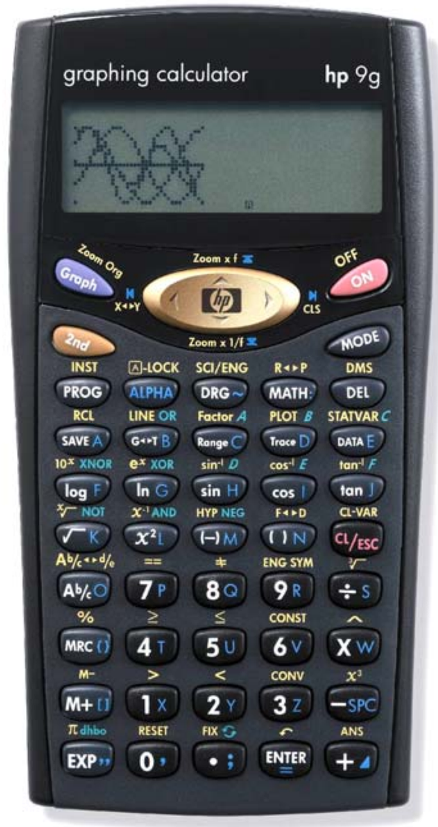
hp calculators

HP 9g Using the Built-in Physical Constants

The CONST Menu

Practice Solving Problems Involving Physical Constants



The CONST menu

The HP 9g includes twenty physics constants that can be used in calculations and included in your programs. All the constant 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 units are not stated.

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

Symbol	Meaning	Value	Keys
c	Speed of light	299792458	2nd CONST 0
Vm	Molar volume of ideal gas	0.0224141	2nd CONST 1
Na	Avogadro's number	6.022136736e23	2nd CONST 2
g	Acceleration of gravity	9.80665	2nd CONST 3
me	Electron mass	9.109389754e-31	2nd CONST 4
G	Gravitational constant	6.6725985e-11	2nd CONST 5
mP	Proton mass	1.67262311e-27	2nd CONST 6
e	Elementary charge	1.602177335e-19	2nd CONST 2nd CONST 0
mn	Neutron constant	6.62607554e-34	2nd CONST 2nd CONST 1
ε_0	Dielectric permittivity	8.854187818e-12	2nd CONST 2nd CONST 2
h	Planck's constant	6.62607554e-34	2nd CONST 2nd CONST 3
φ_0	Flux quantum	2.067834616e-15	2nd CONST 2nd CONST 4
k	Boltzmann's constant	1.38065812e-23	2nd CONST 2nd CONST 5
a_0	Bohr radius	5.291772492e-11	2nd CONST 2nd CONST 6
$\mathfrak{R}$	Gas constant	8.3145107	2nd CONST ▲ 0
μ_0	Magnetic permeability	0.000001257	2nd CONST ▲ 1
μ_B	Bohr magneton	9.274015431e-24	2nd CONST ▲ 2
F	Faraday constant	96485.30929	2nd CONST ▲ 3
μ_N	Neutron magnetic moment	5.050786617e-27	2nd CONST ▲ 4
μ	Atomic mass constant	1.66054021e-27	2nd CONST ▲ 5

The CONST menu is displayed by 2nd CONST . It consists of three menus that display six or five constant 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 position. Notice that it is the symbol that is inserted in the entry line, not the value. Also the shortest keystroke sequences are shown in the above table: note that when the CONST menu is displayed, pressing 2nd CONST displays the next menu of constants.

Constants have to entered using the CONST menu, and cannot be typed in ALPHA mode. In fact, some constants that could be mistaken for variable names (e.g. R, F, G) are displayed bold for this purpose.

The HP 9g constants are not available in the BaseN mode.

Practice solving problems involving physical constants

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

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

2nd CONST 2nd 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 press ENTER again.

Answer: $6.622607554 \times 10^{-34}$

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:

2nd CONST 6 ÷ 2nd CONST 4 ENTER

Answer: mP/me= 1836.152756. Compare it with the value on the HP 48GX (1836.152701) and the one calculated on the HP 33S (1836.1526633). More precision in measures imply new standard values. Constants are not that constant after all!

Example 3: Find the flux density at 5 meters from a long, straight wire that carries current of 9 A.

Solution: The field due to the wire is of magnitude:

$$B = \frac{\mu_0 I}{2\pi r}$$

where r is the perpendicular distance from wire. In our case, r = 5 and I = 9. μ_0 is the magnetic permeability of free space, its value is $4\pi 10^{-7}\ Hm^{-1}$ and is one of the constants in your HP 9g. To find the flux density press:

2nd CONST ▲ 1 9 ÷ ( ) 2 2nd π 5 ENTER

Note the implicit multiplication after the constant name.

Answer: 0.00000036 T

Example 4: 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 our example, the problem is reduced to square c. Press:

[2nd] CONST [0 ,] [x^2 L] [ENTER]

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

Example 5: 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 Y] [x^2 L] [2nd] π dhbo [7 P] [÷ S] [4 T] [EXP] [3 Z] [ENTER]

and now we can calculate P by pressing:

[2nd] CONST ^ [0 ,] [2 Y] [2 Y] [3 Z] [÷ S] [( ) N] [2nd] ANS [– SPC] [3 Z] [• ;] [9 R] [5 U] [EXP] [(–) M] [5 U] ❯ [– SPC] [• ;] [1 X] [4 T] [7 P] [4 T] [÷ S] [2nd] ANS [x^2 L] [ENTER]

Answer: 7229354.15 Pa or 72.3 bar.

Example 6: 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. (Notice that it does *not* depend on the mass of the satellite). The period can be calculated by pressing:

[2] [2nd] [π] [√] [8] [EXP] [6] [2nd] [x³] [÷] [( )] [2nd] [CONST] [5] [5] [•] [9] [8] [EXP] [2] [4] [ENTER]

Answer: 7117.324386 s or 2 hours approximately.