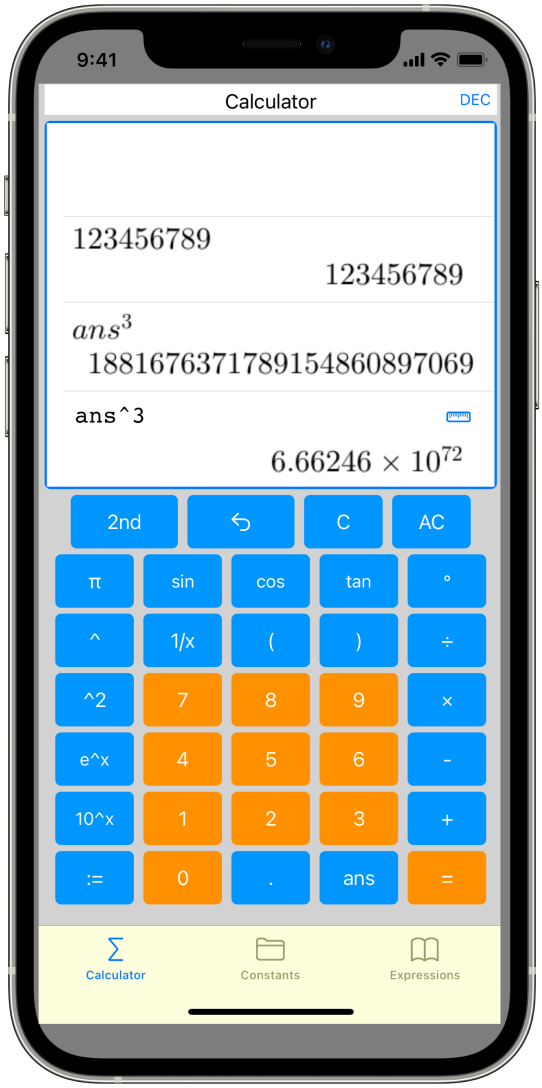
HOW TO USE EXPRESSIONSCALCULATOR



A Revolutionary App that helps you Solve problems

Version 1.0

Expressions Calculator

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ExpressionsCalculator is a multifunction scientific calculator App for iOS offering a wide range of features specific for anyone looking from basic to advanced calculations. It is an ideal tool optimised for **high-school and STEM university students, chemists, engineers, mathematicians and physicists**.

ExpressionsCalculator is revolutionary in the way it helps you solve problems by providing you, in addition to all the basic features of a calculator, a rich sample of **natural constants**, a large database of commonly used **formulae in mathematics, physics and chemistry,** all this in a fully embedded and aware SI (MKSA), imperial (foot, pound, …) and astronomical (ly, parsec, …) **units context**. Hence, in ExpressionsCalculator a physical quantity has a unit. When you perform calculations, units are always taken care of and automatically simplified to provide the most sensible result. Derived units such as Newton, Joule, etc. are handled. Conversions from one unit to others are automatic. In addition, ExpressionsCalculator can also handle multi-dimensional vectorial quantities.

Here is a short overview of the other main features of ExpressionsCalculator:

- *Arithmetics on integers, rational and floating numbers*
- *Handles very large and very small numbers (arbitrary precision arithmetic on integers)*
- *Extended floating point range*
- *Fully embedded handling of units*
- *Large set of available units (SI, imperial) - currently more than fifty!*
- *Handles angles in both degrees and radians*
- *Full calculations with units*
- *Automatic conversion of units*
- *Vector algebra (+,-, scalar and vector products)*
- *Comprehensive list of natural constants with their proper units*
- *Comprehensive list of astronomical constants with their units*
- *Full periodic table with lots of properties for each element*
- *List of refractive indices of many materials*
- *Fully assignable constants with extended naming possibilities*
- *An extensive database of Expressions encompassing most commonly used formulae in mathematics (geometry, vectors), physics (kinematics, dynamics, thermodynamics, optics, special relativity, atomic physics) and chemistry.*

Mathematical Expressions

In ExpressionsCalculator, a calculation is performed with the help of **mathematical expressions** or in short **expressions**. Expressions are built up of words, from either sequences of alphabetic letters or digits or special characters such as +,-,…

ExpressionsCalculator understands standard arithmetic expressions. Some examples: “2+3”,” 2*3”,”2-3","2^3","2+3*4",...

Function calls have their arguments between round brackets, separated by commas. Some examples: “exp(3)”, “cos(pi)”,”ln(10)”.

“ans” represents the answer of the previous calculation.

The Main tab

Figure 1 shows the main tab of ExpressionsCalculator. One can distinguish three main areas:

1) the top frame with current and historical expressions
2) the middle frame with the keys
3) the bottom frame with the tab selectors (labelled Calculator, Constants, and Expressions)

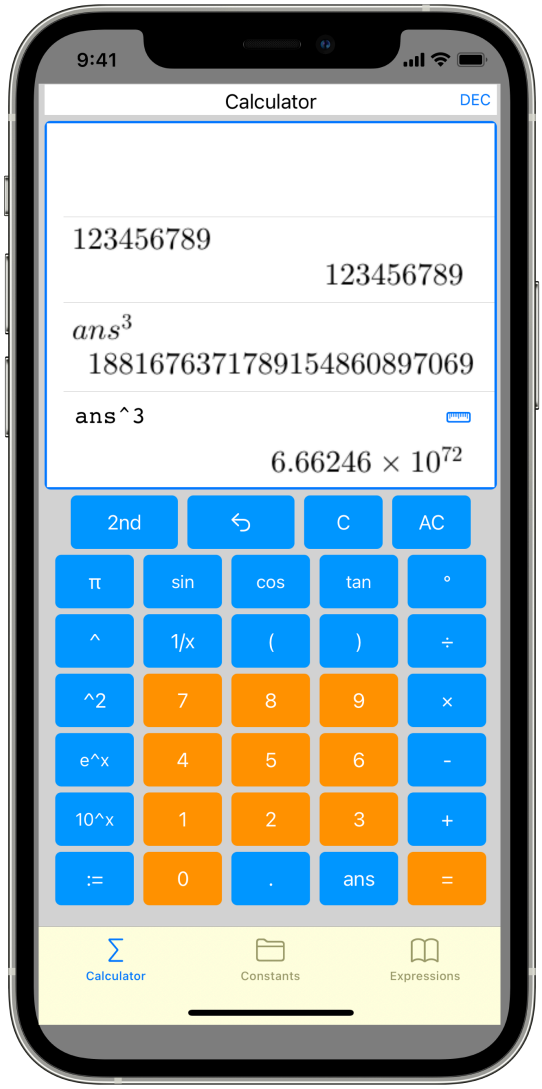

FIGURE 1: THE MAIN VIEW

The key are identified by blue and orange coloured squares. The keys are the following (according to their row order):

a) “2nd” : to access a second set of keys: the “inverse” √, ln and log functions appear instead of the ^2, e^x and 10^x keys. The 7,8,9 and 4 keys are also replaced by x,y,z and t. The sin, cos, tan functions become their inverse asin, acos, atan.

b) ⇐ : the undo key

c) C : the clear key

d) AC: the all clear key

e) π: the irrational pi number

f) sin, cos, tan: the sine, cosine and tangent (change to asin, acos and atan for 2nd key).

g) ° : the degree symbol; it is used to enter angles in degrees, as opposed to angles in radians which is the default otherwise.

h) ^: raising to the given power

i) ^2 or √: square or square-root

j) e^x or ln: the natural number e to the given power or the natural logarithm

k) 10^x or log: ten to the given power or the logarithm in base-10

l) 1/x: the inverse

m) ( ) : left and right parentheses

n) +, x, -, + : the four operations

o) 0, 1, …, 8, 9, 0: the ten digits

p) . or , : to enter dot or comma (used e.g. in conjunction with parentheses for vectors)

q) = : the "compute the result" key

r) := the key to assign a value to an assignable constant

Pressing on an input expression will copy it to the current expressions. Pressing on a result expression will copy it to the current expression. The history of expressions can be scrolled. The clear key "C" will clear the current expression. The all clear key "AC" will clear current and all historical expressions. It also unassigns all assignable constants (see "Assigning Constants").

Using Angles

The default convention for angles is to be expressed in radians. Such convention is for example used by default by trigonometric functions such as sine (*sin*), cosine (*cos*) and tangent (*tan*), and also by their inverse arcsine (*asin*), arccosine (*acos*), and arctangent (*atan*). Accordingly, Expressionscalculator will yield

$$sin(\pi/2) = 1$$

The arc function return a number with radians as explicit units. In order to enter an angle in degrees, just press the ° key after the number, i.e. 45° corresponds to an angle of 45 degrees. Trigonometric function will automatically check the units of their argument. So, as before,

$$sin(90°) = 1$$

The result in radians from an arc function can be converted to degrees by using the "⇄ conversion button appearing next to the result.

Assigning Constants

An assignable constant is a variable, which can be either undefined or be assigned to a value. They possess a name such as "x", "y" or even "E_kin". For example, x is an assignable constant. When unassigned, it will remain as "x" in the expressions. If you enter the polynomial

x^2+2x-5

this latter will be expressed as the original polynomial. You can now assign a value to x with the series of keys "2nd" + "x" + ":=" + <value>, for example

x:=3

In this case, x will be assigned the value of three. If you recompute the polynomial, the result will now be “3^2+2*3-5” which is equal to 10

x^2+2x-5 → 10

Constants can be deleted by swiping them and pressing the Delete button.

The Constants tab

The Constants tab allows to access several tables of most relevance for physics and chemistry. It is shown in Figure 2.

- ***Astronomical constants:*** *The Astronomical constants table contains a large list of constants such as the mass of the Earth, the radius of the Earth, etc… Press on the constants in order to copy their value with corresponding units to the calculator.*

- ***Natural constants:*** *The Natural constants table contains a large list of physical constants such as the speed of light, the Planck constant, … Press on the constants in order to copy their value with corresponding units to the calculator.*

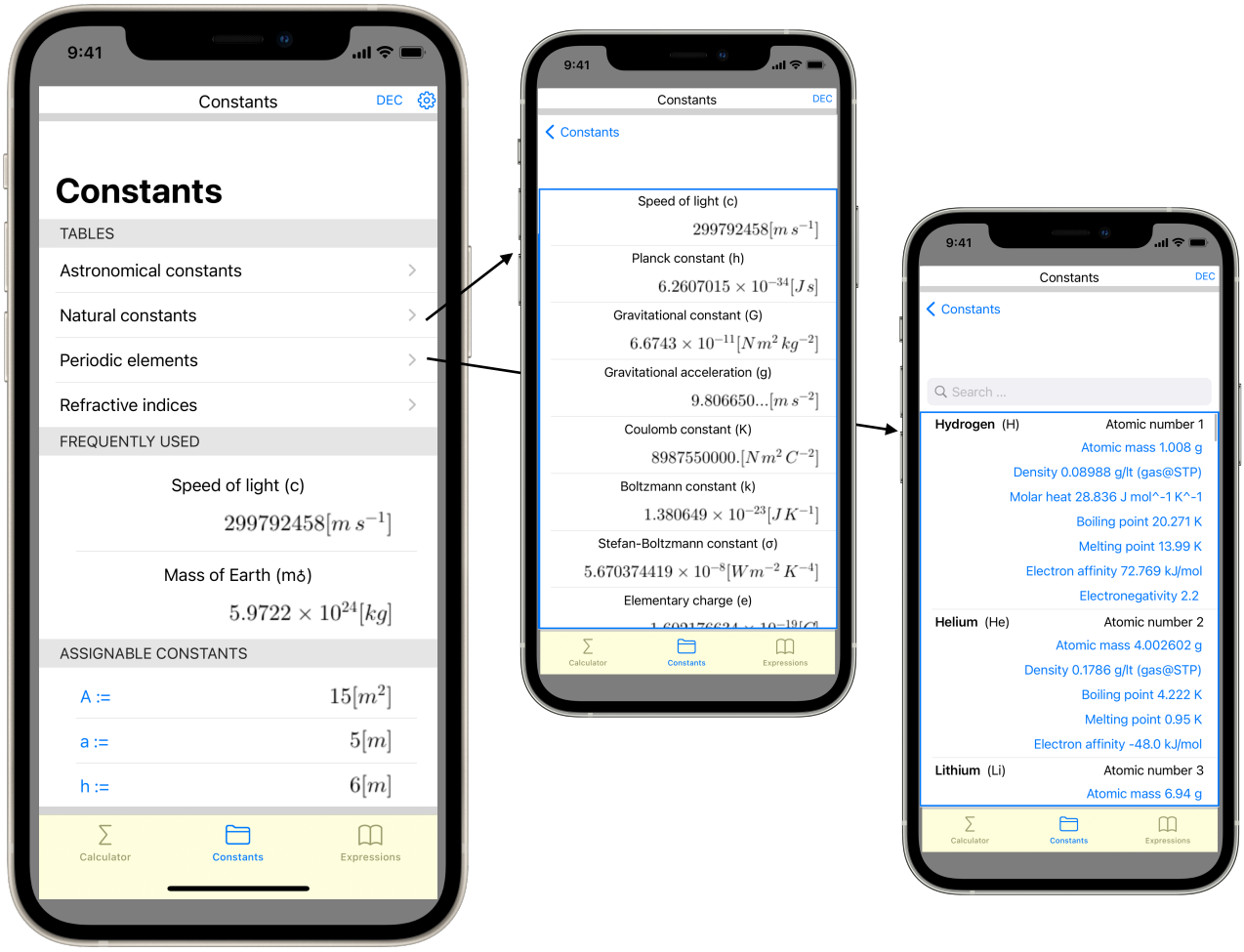

FIGURE 2: THE CONSTANT PANEL AND ITS SUBLISTS

- ***Periodic elements:*** *The Periodic elements table contains the elements and the properties of all elements in the periodic table. It ranges from Hydrogen (Z=1) up to Ununennium (Z=119). For each element, physical properties such as the atomic mass, the density, boiling point, melting point, electron-affinity, electronegativity, etc… are listed. Press on a value in order to copy their value with corresponding units to the calculator.*

- ***Refractive indices:*** *the refractive indices used in optics for many common materials.*

In addition, the panels contains the following lists:

- ***Frequently used:*** *it contains the most recently used constants for easy retrieval.*

- ***Assignable constants:*** *assignable constants are variables. They possess a name such as "x", "y" or even "E_kin". They can be unassigned (or undefined) or be given a value. Undefined variables will be displayed by their name in an expression, for example in the polynomial x^2+2x-3, "x" is an unassigned variable. On the other hand, the ":=" allows the assignment of a value to a variable. Use the key sequence "2nd" + "x" + ":=" + <number> to assign number to "x". In the Figure, "x" has been assigned the value 9.869… (more details in Section "Assigning Constants").*

Units syntax

Units are represented inside square brackets. Units can be exponentiated or prefixed. In the following you can find some typical examples:

- 1 [m] represents one meter
- 2 [s] represents two seconds
- 10 [km/h] or 10 [km h^-1] represent 10 kilometers-per-hour
- 3 [m/s^2] or 3 [m s^-2] represent an acceleration of 3 meter-per-second-squared

The list of available units is listed under "List of Available Units". Units are case sensitive. Both notation e.g. m/s^2 or m s^-2 are accepted. Units can be preceded by a prefix. For example:

1 [ns] represents one nano-second

- *Available prefixes: Y, Z, E, P, T, G, M, k, h, da, d, c, m, mu or µ, n, p, f, a, z, y*

Prefix	Symbol	Factor	Prefix	Symbol	Factor
Yotta	*Y*	10^{24}	**Deci**	*d*	10^{-1}
Zetta	*Z*	10^{21}	**Centi**	*c*	10^{-2}
Exa	*E*	10^{18}	**Milli**	*m*	10^{-3}
Peta	*P*	10^{15}	**Micro**	*mu*	10^{-6}
Tera	*T*	10^{12}	**Nano**	*n*	10^{-9}
Giga	*G*	10^{9}	**Pico**	*p*	10^{-12}
Mega	*M*	10^{6}	**Femto**	*f*	10^{-15}
Kilo	*k*	10^{3}	**Atto**	*a*	10^{-18}

Prefix	Symbol	Factor	Prefix	Symbol	Factor
Hecto	*h*	10^2	**Zepto**	*z*	10^{-21}
Deca	*da*	10^1	**Yocto**	*y*	10^{-24}

List of Available Units

There is a very large set of units available (currently more than 50 different units). In the following, you can find the main units implemented in ExpressionsCalculator:

- *Length: meter [m], inch[in], foot [ft], yard [yd], mile [mi], astronomical unit [AU], light-year [ly], parsec [pc]*
- *Mass: kilogram [kg]*
- *Time: second [s], minute [mn], day [day], year [yr]*
- *Substance: moles [mol]*
- *Temperature: Kelvin [K]*
- *Force: Newton [N], dyne [dyn]*
- *Energy: Joule [J], electron-Volt [eV], calorie [cal], erg [erg], Watt-hour [Wh]*
- *Power: Watt [W], metric horsepower [hp]*
- *Pressure: N/m^2, Pascal [Pa], Torr [torr], atmosphere [atm], bar [bar], pound-force per square inch [psi]*
- *Charge: Coulomb [C]*
- *Capacitance: Faraday [F]*
- *Inductance: Henry [H]*
- *Potential: Volt [V]*
- *Current: Ampère [A]*
- *Magnetic field: Tesla [T]*
- *Area: m^2, acre [acre], are [are]*
- *Volume: m^3, liter [lt], US gallon [galUS], oil barrel [bbl]*
- *Speed: m/s, km/h, knot [kn]*
- *Intensity: W/m^2*

Plus any other combinations of the above units.

Arithmetics with units calculations

Full set of arithmetics operations with units is available. You can find in the following some typical examples of calculations with units. Try them out!

1 [s] + 30 [s]
30 [s] + 1 [mn]
1 [m] + 1 [km]
1 [m] * 2 [m] = 2 [m^2]
1 [m] * 200 [cm] = 20000. [cm^2]
2 [m] / 1 [m] = 2
2 [m] / 1 [cm] = 200.
1 [m] + 50 [s] yields Units error
1 [h] + 50 [s] = 3650. [s]

1 [h] - 50 [s] = 3550. [s]
1 [mi] + 1 [km] = 2609.34… [m]
50 [m] / 2 [s] = 25 [m s^-1]
1 [bar] + 1 [atm] = 201325. [Pa]
1 [kn] + 10 [km/h] = 3.29222… [m s^-1]
(10 [km/h])^2 = 7.716049… [m^2/s^2]

Possibilities are virtually limitless!

Vectors

To define a vector, put the elements separated by a comma, with normal brackets (...) as delimiters. Example:

(1,2,3)

One can use standard operations such as vector adding, subtracting. For example:

(1,2)+(3,4)+(5,6) = (9,12)
(1,2,3+234) + (3,4,5) = (4,6,242)

The scalar product (*) and the vector (×) product are also defined. For example:

(1,2,3)*(4,5,6) = 32
(1,2,3) × (4,5,6) = (-3, 6, -3)
(1,2,3) × (3,4,6) = (0,3,-2)

By default, vectors are expressed in cartesian coordinates. A three dimensional vector can be expressed in spherical or cylindrical coordinates by adding an underscore. For example:
(3, pi/2, 0)_s or (10, 30°, 20°) for spherical coordinates, and (3, pi/3, 10)_c for cylindrical coordinates. Spherical coordinates use the physicists' convention.

The Expressions tab

The expressions tab is shown in Figure 3. It allows accessing a very extended list of formulae which can be readily used in the calculator. The expressions are organised by three main fields:

- mathematics
- physics
- chemistry

Each field has subfields that more precisely defines the relevance of the formulae. Once a formula has been found in the easily scrollable lists, click on it to copy it into the calculator. An expression is characterised by:

1) *its main expression*
2) *one or many unassigned variables with predefined units*
   Once copied to the calculator, the unassigned variables can be easily given a value. Their units can also be changed within the possible types of units. For example, if the variable "x" represents a length, then the list of its possible units proposed by ExpressionsCalculator will reflect this fact. When a variable is assigned, pressing the "=" key updates the result. Of course, the result is also presented with its corresponding units. It's totally unbelievable.

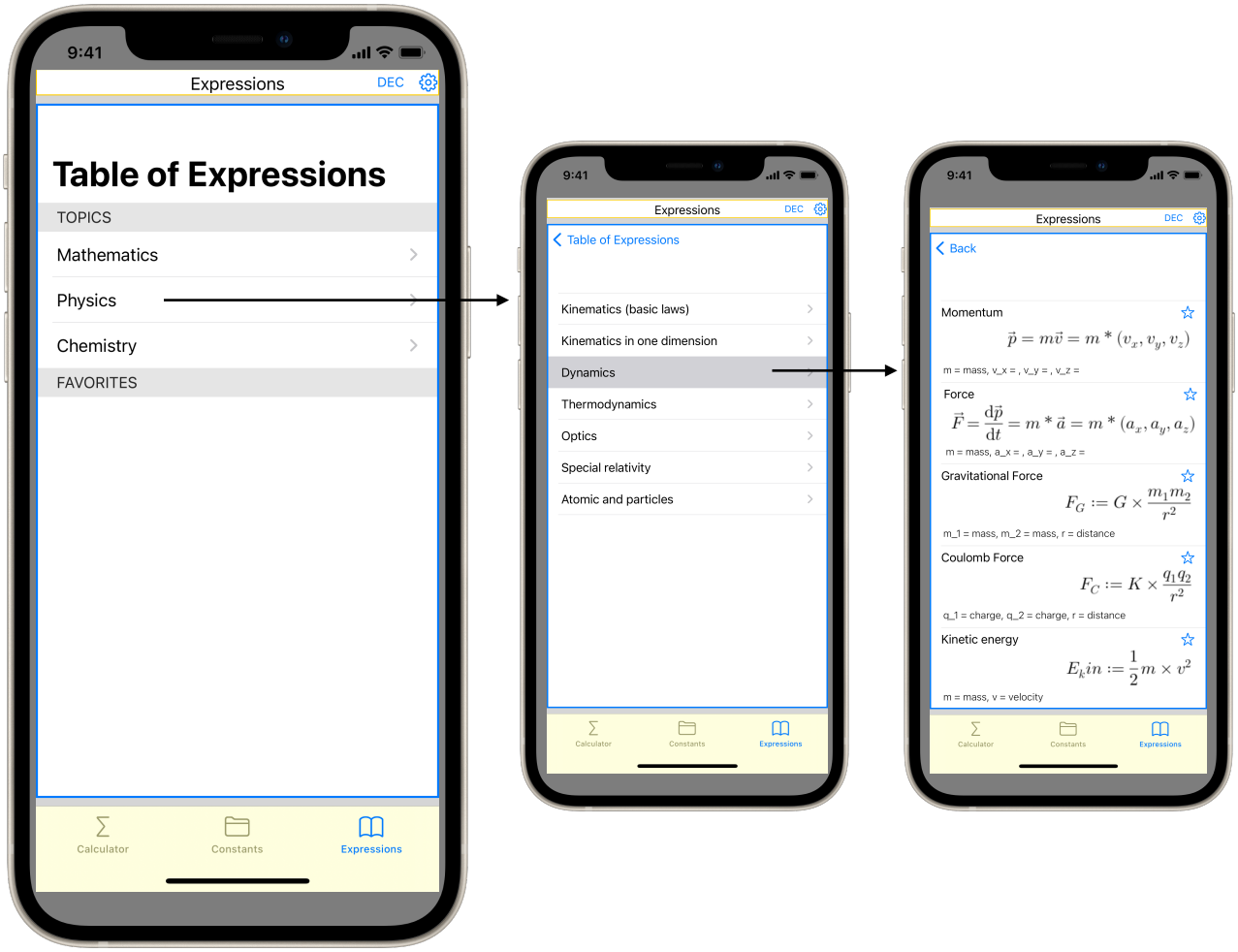

FIGURE 3: THE EXPRESSIONS TAB AND ITS SUBLISTS (IN THE FIGURE THE PHYSICS→DYNAMICS SUBCATEGORY IS SHOWN).

How to effectively use the Expressions tab

Press on an expression in the expressions tab to copy it to the main calculator view. The sequence is shown in Figure 4. The copied expression appears in the main tab on multiple lines. The first line shows the expression in input form. Below it, the unassigned variables are listed, with their meaning in gray and their SI units. The values can be entered and the units can be changed by pressing on the ruler button. Once the desired variables have been set, the result of the calculation can be obtained by pressing the "=" key. In the example, the distance in the rectilinear uniform motion is shown. It has three unknowns: the velocity, the time and the initial position. These are set to respectively v = 10 [m/s], t = 5 [s] and x_0 = 0 [m]. The corresponding result is then 50 [m].

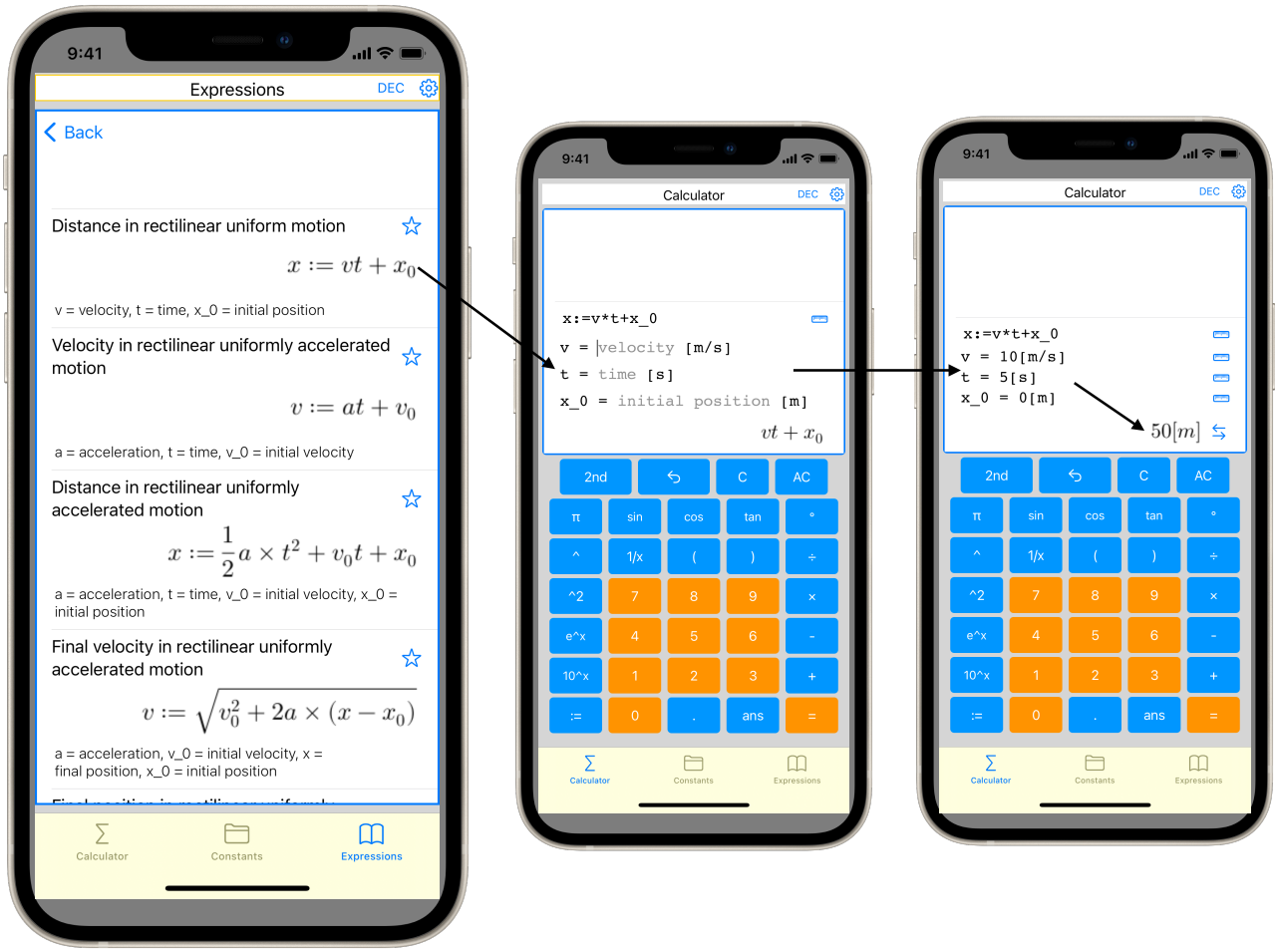

FIGURE 4: THE SEQUENCE ON HOW TO USE THE EXPRESSIONS FORMULA.