CALCIXA · TRUE-FORM MATH

CT-500 PRO

USER MANUAL & FORMULA HANDBOOK

The keypad, the modes, and every SHIFT and ALPHA function explained and verified against the app itself — followed by the algebra, trigonometry, geometry, calculus, statistics and constants a student reaches for, each cross-referenced back to the keys that compute it.

27 sections · True-Form Math · Printable A4 · Verified against source

Contents

27 sections, in the order they appear

PART ONE · USING THE CALCIXA CT-500 PRO

PART TWO · FORMULA HANDBOOK

PART ONE

Using the Calcixa CT-500 PRO

Every key, every mode, and every setting — checked against the app's own source, not against memory of some other machine.

01 · The Keypad

Every physical key: its plain meaning, its gold SHIFT meaning, its red ALPHA meaning

KEY	PLAIN	SHIFT	ALPHA
SHIFT	arms the gold prefix for the next key (the S annunciator lights)	—	—
ALPHA	arms the red prefix for the next key (the A annunciator lights)	—	—
MODE	opens the mode menu (1 COMP … 8 TABLE)	opens the on-glass SETUP menu, page 1 of 2	—
ON	powers on; AC when already on	—	—
◀ REPLAY ▶	moves the cursor; steps into a fraction/root/power instead of jumping over it	jumps to the start / end of the expression	—
▲ REPLAY ▼	hops between a shape's boxes; outside a shape, walks the last 40 calculations	same as plain (no separate SHIFT action)	—
CALC	CALC — prompts for each variable's value, then evaluates	SOLVE — solves the expression for X	= (chains statements)
∫ (integral)	∫ template: lower limit, upper limit, integrand	d/dx(— derivative, typed as a function call	: statement separator
x^{-1} (reciprocal)	raises the previous value to the power −1	x! factorial	—
$\log_{▫}(▫)$	log with a subscript base: base, then argument	Σ summation: lower limit, upper limit, term	—
▫/▫ (fraction)	stacked fraction template	a b/c mixed-fraction template	—
√▫ (square root)	square-root template	$\sqrt[3]{▫}$ cube root (degree fixed at 3)	—
x^2 (square)	squares the previous value	x^3 cubes the previous value	DEC — BASE-N to decimal
x^▫ (power)	power template, exponent box	$\sqrt[n]{▫}$ n-th root, both boxes editable	HEX — BASE-N to hex
log	log(— base-10 logarithm	10^▫ template	BIN — BASE-N to binary
ln	ln(— natural logarithm	e^▫ template	OCT — BASE-N to octal

01 · The Keypad

Every physical key: its plain meaning, its gold SHIFT meaning, its red ALPHA meaning

ALPHA+ENG is printed as *i* but shows "The imaginary unit needs CMPLX, which is not fitted" even while CMPLX is selected — type *i* with the **i** soft key in the CMPLX context strip instead.

KEY	PLAIN	SHIFT	ALPHA
(–) negate	unary minus	∠ polar-angle entry (toasts "needs CMPLX" outside it)	A (variable)
°‴ (DMS)	types °	converts the shown decimal answer to D°M′S″	B (variable)
hyp	arms the hyperbolic prefix for the next sin/cos/tan	Abs(— absolute value	C (variable)
sin	sin(	$\sin^{-1}$(($\sinh^{-1}$(if hyp is armed)	D (variable)
cos	cos(	$\cos^{-1}$(($\cosh^{-1}$()	E (variable)
tan	tan(	$\tan^{-1}$(($\tanh^{-1}$()	F (variable)
RCL	arms recall of a variable	arms store (STO) of a variable	—
ENG	steps the shown exponent right by 3	steps it left by 3	i — printed only; see note below
(	open parenthesis	% percent	—
)	close parenthesis	, argument separator	X (variable)
S⇔D	toggles the answer between exact and decimal	toggles a b/c ↔ d/c fraction style	Y (variable)
M+	adds the shown value to memory M	M− subtracts it	M (variable)

01 · The Keypad

Every physical key: its plain meaning, its gold SHIFT meaning, its red ALPHA meaning

The gold legends MATRIX, VECTOR, STAT, CMPLX and BASE printed over 4, 5, 1, 2 and 3 are the familiar shortcut layout from other scientific calculators, but on the CT-500 PRO they are not wired up: pressing SHIFT then that digit shows "This mode is not fitted on this model." Switch modes with the MODE key or the mode strip under the display instead.

KEY	PLAIN	SHIFT	ALPHA
7	7	CONST — opens the 40-entry constants picker	—
8	8	CONV — opens the 40-entry conversions picker	—
9	9	CLR — opens the Setup / Memory / All clear menu	—
DEL	deletes the item left of the cursor	INS toggles insert / overwrite	—
AC	clears the entry (memory and SETUP are untouched)	OFF powers down	—
4	4	MATRIX — printed only; see note below	—
5	5	VECTOR — printed only; see note below	—
6	6	—	—
×	multiply	nPr(permutations	—
÷	divide	nCr(combinations	—
1	1	STAT — printed only; see note below	—
2	2	CMPLX — printed only; see note below	—
3	3	BASE — printed only; see note below	—
+	add	Pol(rectangular → polar	—
−	subtract	Rec(polar → rectangular	—
0	0	Rnd(rounds to the current display precision	—
.	decimal point	Ran# random number, 0–1	RanInt(random integer in a range
×10ˣ	×10 then a power box (scientific entry)	π	e
Ans	recalls the last answer	DRG▶ cycles the angle unit Deg → Rad → Gra	—
=	evaluates the expression	—	—

02 · SHIFT, ALPHA and the REPLAY Pad

The two prefix keys, four-way cursor movement, DEL/INS and AC/OFF

SHIFT and ALPHA

SHIFT arms the gold function printed above a key; ALPHA arms the red one. Press once to arm — the S or A annunciator lights on the display — then press any key to use its prefixed meaning. Pressing SHIFT or ALPHA again cancels it, and any other keypress consumes it even if that key has no prefixed meaning of its own.

ALPHA mostly reaches the nine addressable variables A–F, X, Y and M, which are silk-screened above six of the function keys. Ans is the exception: it has its own key and needs no ALPHA.

The REPLAY pad

◀ and ▶ move the cursor one place at a time. Landing on a 2D shape from the left steps the cursor into its first box rather than jumping over the whole shape; SHIFT+◀ and SHIFT+▶ instead jump straight to the start or end of the entire expression.

▲ and ▼ hop between the boxes of the shape the cursor is currently inside — for example between a fraction's denominator and its numerator. Outside any shape they walk backwards and forwards through the last 40 completed calculations (the HIST scrollback), which is why the ▼ and ▲ annunciators only light when there is somewhere to go.

Worked example. Type **1**, then press the fraction key: 1 lands in the numerator and the cursor jumps to the denominator automatically. Type **2**: the display now shows the stacked fraction $\frac{1}{2}$. Press ▲ to jump back up into the numerator and edit it, or ▶ to leave the fraction and keep typing after it.

DEL, INS, AC and OFF

DEL removes the item immediately left of the cursor. On a 2D shape it dissolves the shape and splices its contents back into the row rather than deleting the whole thing in one press. DEL on a displayed error clears the error and returns the cursor to the point of the fault instead of deleting a character. SHIFT+DEL is INS: it toggles overwrite mode, so typed characters replace what is under the cursor instead of pushing it along.

AC clears the current entry, any error and any open menu — but never memory, variables or SETUP. SHIFT+AC is OFF, which powers the machine down to a blank screen; ON wakes it back up to a fresh, empty entry line.

03 · True-Form Entry

Fractions, roots, powers, logs with a base, ∫, Σ and Π — and how to tell which box you are in

The idea

Natural layout	True-Form Math lays an expression out the way it is written on paper: fractions stack, powers rise, roots grow a bar over their contents.
Empty boxes	Every 2D shape appears with one or more small empty boxes (▫). The cursor lands inside the first one, waiting to be filled.
Finding the cursor	The flashing cursor sits inside exactly one box at a time; whatever is typed next goes into that box, and only that box.
Moving between boxes	▲ and ▼ hop between a shape's own boxes; ▶ off the last box steps back onto the main line, after the whole shape.

One-box shapes

√▫ square root	One box: the radicand.
x^▫ power	One box: the exponent, raising whatever was typed or computed just before the key was pressed.
x^2, x^3, x^{-1}	Fill the exponent box automatically with 2, 3 or −1 and step straight back onto the baseline — no box is left open.
$\sqrt[3]{▫}$ cube root	One editable box (the radicand); the degree is fixed at 3.

Two-box shapes

▫/▫ fraction	Numerator, then denominator. The cursor starts in the numerator.
$\sqrt[n]{▫}$ n-th root	Degree, then radicand. The cursor starts in the degree box.
log▫(▫) log base	Subscript base, then argument.
a b/c mixed fraction	Whole part, numerator, denominator — three boxes, filled left to right.

Three-box shapes

∫ integral	Lower limit, upper limit, integrand — evaluated numerically (Simpson's rule) with X as the variable of integration.
Σ summation (SHIFT + log▫)	Lower limit, upper limit, term in X. Stays an exact fraction while every term does.
Π product (COMP context strip)	Same three-box shape as Σ, multiplying instead of adding.
d/dx(derivative (SHIFT + ∫)	Not a boxed shape — a normal function call. Type the expression, a comma, then the point: d/dx(X^2,3).

03 · True-Form Entry

Fractions, roots, powers, logs with a base, ∫, Σ and Π — and how to tell which box you are in

Worked: definite integral

Keys	Press ∫, type X^2 into the third box, 0 into the lower box, 1 into the upper box, then =.
Result	0.3333333333 — integrals are always numeric (a Real value), never an exact fraction, because they are computed by Simpson's rule rather than symbolically.

Worked: summation

Keys	Press SHIFT then log ▫ for Σ, set the lower box to 1, the upper box to 4, and the term to 1/X, then =.
Result	$\frac{25}{12}$ exactly — Σ stays an exact fraction as long as every term does.

Worked: derivative

Keys	Type X^2 in one place mentally, then type `d/dx(X^2,3)` directly (SHIFT + ∫ opens "d/dx(").
Result	6 — the slope of X^2 at $X = 3$, found by Ridders' extrapolation, not a symbolic rule.

Reading the boxes

Nesting	Boxes can hold further shapes: a fraction inside a root, a power inside a fraction — the cursor still only ever sits in one innermost box.
Leaving a shape	DEL at the head of a box dissolves the enclosing shape rather than the box's own contents, splicing everything back onto one line.

04 · The Display

Every annunciator along the top edge of the LCD, and how the two lines of the glass are shared

ANNUNCIATOR	LIGHTS WHEN
S	SHIFT is armed, waiting for the next key.
A	ALPHA is armed, waiting for the next key.
M	independent memory M holds a non-zero value.
STO	waiting for a variable key to store the shown value into.
RCL	waiting for a variable key to recall.
hyp	the hyperbolic prefix is armed for the next sin, cos or tan.
Mode letter	shows **i** in CMPLX, **b** in BASE-N, **STAT** in STAT mode; blank in COMP, EQN, MATRIX, VECTOR and TABLE.
FIX / SCI	the display is fixed to a set number of decimal places (FIX) or forced to scientific notation (SCI); blank in Norm1, Norm2 or Eng.
D / R / G	shows the active angle unit: Degrees, Radians or Gradians.
Math	Natural (2D) input/output is selected in SETUP; unlit in Line I/O.
▼	at least one calculation has been completed this session — there is scrollback to step into.
▲	REPLAY can still step further back — it goes dark on the oldest line of the scrollback.

Unlit annunciators are drawn at very low opacity rather than hidden, matching how a real segment display looks: the segments are always physically there.

05 · S⇔D, ENG and Exact Answers

Why 1÷3 shows a fraction, why 0.1+0.2 shows a clean 0.3, and how far exactness reaches

S⇔D and ENG

S⇔D	Toggles the last answer between its exact form (fraction, surd or a multiple of π) and its decimal approximation. It only changes the display — nothing is recomputed — and it also cancels any ENG shift in effect.
ENG	Steps the exponent of a shown decimal answer up by one engineering step (×1000, so the mantissa re-centres between 1 and 1000). SHIFT+ENG steps it down. Only works once an answer is on screen.

What stays exact

Rational arithmetic	$+, -, \times, \div$ and integer powers of an exact fraction stay an exact fraction.
Surds	$\sqrt{n}$ of a non-square integer becomes an exact surd, and survives further $+, -, \times, \div$ by a rational, or by another surd with a matching radicand.
π	Carries through multiplication or division by a rational, so π÷3 prints as a stacked $\frac{\pi}{3}$, not 1.047197551.
Standard-angle trig	sin, cos and tan of the standard degree angles (0, 30, 45, 60, 90…) return an exact value in DEG mode, e.g. $\sin(30°) = \frac{1}{2}$.

Why 1÷3 shows a fraction

The rule	A literal decimal point, a %, or Ran# anywhere in the typed expression forces the answer into decimal form. 1÷3 contains none of those, so the exact result $\frac{1}{3}$ is shown stacked.
On Calcixa	Type 1÷3, press =. Press S⇔D to see 0.3333333333.

Why 0.1+0.2 shows 0.3

Exact input	Decimal literals are parsed straight into exact fractions $\frac{1}{10}$ and $\frac{1}{5}$, and added exactly to give $\frac{3}{10}$. No binary floating-point arithmetic ever happens.
Forced decimal	The typed expression contains decimal points, so the rule above forces the display into decimal form — and because the value really is exact, that decimal is a clean 0.3, never 0.30000000000000004.

06 · Memory

A–F, X, Y, M and Ans, and how STO, RCL, M+ and M− reach them

The nine variables

A–F	Silk-screened in red above NEGATE, °’”, hyp, sin, cos and tan.
X, Y, M	Above), S⇔D and M+.
Ans	Its own key — no ALPHA needed. Holds the value of the last evaluated expression.
In HEX	A–F type as hexadecimal digits instead of variables while BASE-N is set to Hex.

STO and RCL

RCL	Arms recall — the RCL annunciator lights — then the next variable key inserts its value into the entry.
SHIFT+RCL	Arms store (STO annunciator lights): the value on the answer line is written into the next variable key pressed, confirmed by a toast such as "A ← 5".
On Calcixa	SHIFT, RCL, then sin stores the shown answer into D.

M+ and M−

M+	Adds the shown value to the independent memory M.
SHIFT+M+	M− subtracts the shown value from M instead.
M annunciator	Lit whenever M holds anything other than zero.

Clearing and persistence

CLR menu	SHIFT+9 opens Setup / Memory / All. Memory zeroes M and every variable; All also resets SETUP and returns to COMP mode.
What survives a restart	The current mode, number base, SETUP and all nine variables are saved between launches. The entry line itself is never remembered.

07 · SOLVE and CALC

Substituting values into an expression, and finding a root numerically

CALC

Plain CALC key	Prompts for the value of every variable the typed expression uses, in keypad order (A, B, C, D, E, F, X, Y, M), then evaluates.

SOLVE

SHIFT+CALC	Treats the entry as an equation — splitting on the first "=" if there is one, otherwise solving expression = 0 — and solves for X, prompting first for any other variable it uses.
Method	Newton–Raphson from X's current stored value; after 100 steps it falls back to a bracketed bisection sweep between −1000 and 1000.

Worked example

Type	$X^2-5X+6=0$, then press SHIFT+CALC.
Result	Starting from X's default value of 0, Newton's method converges to $X = 2$, reported with the residual L−R (left-hand side minus right-hand side, ≈ 0).
Note	The other root, $X = 3$, is not shown — SOLVE reports one root, whichever the search reaches first from where X currently stands. Change X first (e.g. STO 4 into X) to land on the other one.

08 · COMP Mode

The default arithmetic mode — every expression above returns an exact answer whenever it can

What changes

On selecting COMP	Plain real-number arithmetic; fractions, surds and π stay exact until a decimal forces them out (Section 5).
Context strip	CONST, CONV, Π, GCD, LCM, Abs, Rnd, %.

Worked example

Type	$\sqrt{(3^2+4^2)}$, then =.
Result	5 — a 3-4-5 right triangle, and an exact integer since every step stayed exact.

09 · CMPLX Mode

Complex arithmetic — the guards on √ and ln relax so a negative input resolves into a complex result

What changes

On selecting CMPLX	sqrt of a negative number, ln of a negative number and similar cases resolve to a complex value instead of a Math ERROR. Results become plain doubles (re, im pairs) rather than exact fractions.
Typing i	Use the **i** soft key on the context strip — the case legend ALPHA+ENG is not wired to it (Section 1).
Context strip	i, Abs (modulus), Arg, Conjg, ∠ (polar entry), and a toggle between a+bi and r∠θ display.

Worked example

Type	$(2+3i)\times(1-i)$, then =.
Result	$5+i$, since $(2+3i)(1-i) = 2-2i+3i-3i^2 = 2+i+3 = 5+i$.
Then	Toggle to r∠θ: $\lvert 5+i\rvert = \sqrt{26} \approx 5.0990$, Arg ≈ 11.31° (DEG mode).

10 · BASE-N Mode

Integer arithmetic in binary, octal, decimal or hexadecimal — 32-bit, two's complement

What changes

On selecting BASE-N	Every result becomes a 32-bit two's-complement integer; fractions no longer exist. Division truncates toward zero, so −7÷2 gives −3, not −4. A result outside the 32-bit range is a Math ERROR.
Context strip	Dec, Hex, Bin, Oct base selectors, then and, or, xor, xnor, not, Neg.
Hex digits	A–F on the ALPHA-lettered keys type as hexadecimal digits while Hex is selected.

Worked example

Decimal 205	is CD in hex, 11001101 in binary, 315 in octal.
Bitwise	CD and 0F = 0D (13): 1100 1101 masked with 0000 1111 keeps only the low nibble.

11 · STAT Mode

One-variable statistics, plus seven two-variable regressions, all sharing one grid

1-VAR

Grid	x, and an optional frequency column.
Results	n, Σx, Σx^2, $\bar{x}$ (mean), σx (population std. dev.), sx (sample std. dev., blank when n<2), min, Q1, median, Q3, max.
Quartiles	By the median-of-halves ("Tukey hinge") method: split the sorted data at its median, excluding the middle point when n is odd, then take the median of each half.

Worked: 1-VAR

Data	2, 4, 4, 4, 5, 5, 7, 9
Result	n=8, $\bar{x}$=5, σx=2 (population), sx=$\sqrt{(32/7)}$≈2.138 (sample).

11 · STAT Mode

One-variable statistics, plus seven two-variable regressions, all sharing one grid

The seven regressions

Linear	$y = A + Bx$
Quadratic	$y = A + Bx + Cx^2$
Logarithmic	$y = A + B \cdot \ln x$
Exponential	$y = A \cdot e^{(Bx)}$

…continued

ab^x	$y = A \cdot B^x$
Power	$y = A \cdot x^B$
Inverse	$y = A + B/x$
Every model	reports a correlation coefficient r, and offers $\hat{y}$ (estimate y from a typed x) and $\hat{x}$ (estimate x from a typed y). A quadratic fit reports both $\hat{x}$ roots, since it is two-valued.

Worked: linear regression

Data	$x = 1,2,3,4$ $y = 3,5,7,9$
Result	$A=1$, $B=2$, $r=1$ — a perfect fit to $y = 1+2x$.

12 · EQN Mode

Six variants: simultaneous linear systems of 2–4 unknowns, and single quadratic, cubic or quartic equations

Simultaneous systems

2, 3 or 4 unknowns	Coefficients go in a grid, one row per equation, the constant term in the last column. SOLVE runs Gaussian elimination with partial pivoting and also reports the determinant. A singular system is reported as "no solution" or "infinitely many", never a wrong answer.

Polynomials

Quadratic, cubic, quartic	Coefficients highest power first. SOLVE returns every root — real or complex — with the count of real roots reported alongside.

Worked: 2 unknowns

Type	$X+Y=5$ and $X-Y=1$ into the grid.
Result	$X=3$, $Y=2$, det $= -2$.

Worked: quadratic

Type	$X^2-5X+6=0$ ($a=1, b=-5, c=6$).
Result	Roots 2 and 3 — 2 real roots.

13 · MATRIX Mode

2×2, 3×3 or 4×4 — matrices A and B share one grid, one above the other

Actions

A+B, A−B, A×B	Elementwise or matrix products, shape-checked before running.
det A, A^{-1}, A^{T}, rank A, tr A	Determinant and inverse by Gauss–Jordan elimination with partial pivoting (a near-singular matrix is reported as singular rather than returning a garbage inverse); rank by the same pivoted elimination; trace is the sum of the leading diagonal.

Worked example

A	[[1,2],[3,4]]
B	[[5,6],[7,8]]
A+B	[[6,8],[10,12]]
det A	-2, so A^{-1} = [[−2,1],[1.5,−0.5]]

14 · VECTOR Mode

2D or 3D — three vectors A, B and C, because the scalar triple product needs three

Actions

A+B, A−B, A·B, A×B	Cross product always returns three components; a 2D vector is treated as having $z = 0$.
|A|, |B|, unit A, ∠AB, A·(B×C)	The angle between two vectors is computed from $\text{atan2}(\lvert A \times B \rvert, A \cdot B)$ rather than the textbook arccosine, which stays accurate even for near-parallel vectors.

Worked example

A	$(1, 2, 3)$
B	$(4, 5, 6)$
A+B	$(5, 7, 9) \cdot A \cdot B = 32 \cdot A \times B = (-3, 6, -3)$
|A|	$\sqrt{14} \approx 3.742$

15 · TABLE Mode

A two-column X, f(X) table from a typed function, start, end and step

How it works

Prompts	f(X)=, Start, End, Step, in that order, each finished with =.
Reading it	REPLAY ▲▼ scrolls the table; = starts a fresh one. Up to 300 rows are generated.

Worked example

f(X)	X^2
Start, End, Step	1, 5, 1
Table	1→1, 2→4, 3→9, 4→16, 5→25

16 · The Mode Strip, Context Strip, HIST and SETUP

The controls under the display, the working-out sheet, and every setting SETUP holds

Mode strip

What it is	Eight direct buttons under the display, one per mode, bypassing the paged MODE menu entirely.
Safety	Re-selecting the mode you are already in does nothing, so a mis-tap never clears what you were typing.

Context strip

What it is	A second row of soft keys that changes with the mode — whatever that mode actually needs, rather than whatever fitted on a 2008 case.
Which modes get one	COMP, CMPLX, BASE-N and TABLE each have their own row (Sections 8, 9, 10, 15). EQN, MATRIX, VECTOR and STAT instead show their grid's own action buttons (Sections 11–14) — nothing extra is drawn for a mode with nothing further to add.

HIST

What it does	Slides a working-out sheet up over the keypad, listing every completed calculation this session (up to 40).
Why use it	Tapping any line reloads it into the entry line for editing — faster than pressing REPLAY-▲ repeatedly to walk back to it.

Two routes to SETUP

SHIFT+MODE	Opens the classic two-page on-glass menu (next page).
Gear icon on the nameplate	Opens the fuller SETUP sheet, covering the same calculation settings plus two behaviour switches and data actions (next page).

16 · The Mode Strip, Context Strip, HIST and SETUP

The controls under the display, the working-out sheet, and every setting SETUP holds

On-glass SETUP, page 1

MthIO / LineIO	Natural 2D display, or one flat line.
Deg / Rad / Gra	The angle unit.
Fix / Sci / Norm	Fix asks for 0–9 decimal places; Sci asks for 1–10 significant figures; Norm asks 1 or 2 (see below).

On-glass SETUP, page 2

a b/c / d/c	Mixed fraction display, or improper (top-heavy) fractions.
Dec / Hex / Bin / Oct	The active BASE-N base.

SETUP sheet — Calculation

Angle	Deg, Rad, Gra.
Display	Norm1, Norm2, Fix, Sci, Eng — Fix and Sci add a digit stepper (0–9 or 1–10).
Input, Fraction, Complex	Math/Line; a b/c vs d/c; a+bi vs r∠θ.

SETUP sheet — Behaviour and Data

Key vibration, Keep screen on	Two switches with no on-glass equivalent.
Clear memory	Zeroes M and every variable.
Reset everything	Also restores SETUP to its defaults and returns to COMP mode.

Norm1 vs Norm2

Shared rule	Both switch to scientific notation once the magnitude reaches 1×10^{10}.
The difference	Norm1 also switches below 1×10^{-2}; Norm2 holds off until below 1×10^{-9}, showing more small numbers in full.

17 · Constants and Conversions

Two 40-entry indexed pickers, opened with SHIFT+7 and SHIFT+8

CONST — SHIFT+7

What it does	Opens a 40-entry list of physical constants. Choosing one inserts its symbol into the entry, carrying the value with it.
Source	CODATA 2022 recommended values. The five SI-defining constants — c, h, e, k, N_A — are exact by definition since the 2019 redefinition; everything derived purely from them (ħ, R, F, the radiation constants, σ, Φ_0, G_0) is computed to full double precision rather than pasted as a rounded literal.

CONV — SHIFT+8

What it does	Opens a 40-entry list of unit conversions. Choosing one converts the value already on the answer line and writes the result back as a fresh answer.
Order of operations	Calculate the value first, then convert it — CONV acts on Ans, it does not type a conversion function.

Why temperature is different

Affine, not a ratio	Every other conversion is value × factor. °F ↔ °C also needs an additive offset (0°C = 32°F, and a Fahrenheit degree is $^5/_9$ the size of a Celsius one), so those two rows carry an offset applied after the multiply.

Exact vs derived factors

Exact by international agreement	The inch, foot, yard, mile, pound, nautical mile, US and UK gallons, calorie, Btu, atmosphere and standard gravity are all exact definitions, not measurements.
Derived exactly from those	The parsec, foot-pound, horsepower and pound-force are computed here from the exact definitions above rather than pasted as rounded literals.

17 · Constants and Conversions

Two 40-entry indexed pickers, opened with SHIFT+7 and SHIFT+8

#	SYMBOL	NAME	VALUE (SI)	UNIT
1	m_p	Proton mass	$1.67262192595 \times 10^{-27}$	kg
2	m_n	Neutron mass	$1.67492750056 \times 10^{-27}$	kg
3	m_e	Electron mass	$9.1093837139 \times 10^{-31}$	kg
4	m_μ	Muon mass	$1.883531627 \times 10^{-28}$	kg
5	a_0	Bohr radius	$5.29177210544 \times 10^{-11}$	m
6	h	Planck constant (exact)	$6.62607015 \times 10^{-34}$	J s
7	μ_N	Nuclear magneton	$5.0507837393 \times 10^{-27}$	J T^{-1}
8	μ_B	Bohr magneton	$9.2740100657 \times 10^{-24}$	J T^{-1}
9	ħ	Reduced Planck constant (= h/2π)	$1.054571817 \times 10^{-34}$	J s
10	α	Fine-structure constant	$7.2973525643 \times 10^{-3}$	—
11	r_e	Classical electron radius	$2.8179403205 \times 10^{-15}$	m
12	λ_C	Compton wavelength	$2.42631023538 \times 10^{-12}$	m
13	γ_p	Proton gyromagnetic ratio	$2.6752218708 \times 10^{8}$	s^{-1} T^{-1}
14	λ_{Cp}	Proton Compton wavelength	$1.32140985360 \times 10^{-15}$	m
15	λ_{Cn}	Neutron Compton wavelength	$1.31959090382 \times 10^{-15}$	m
16	R_∞	Rydberg constant	$1.0973731568157 \times 10^{7}$	m^{-1}
17	u	Atomic mass unit	$1.66053906892 \times 10^{-27}$	kg
18	μ_p	Proton magnetic moment	$1.41060679545 \times 10^{-26}$	J T^{-1}
19	μ_e	Electron magnetic moment	$-9.2847646917 \times 10^{-24}$	J T^{-1}
20	μ_n	Neutron magnetic moment	$-9.6623653 \times 10^{-27}$	J T^{-1}

17 · Constants and Conversions

Two 40-entry indexed pickers, opened with SHIFT+7 and SHIFT+8

#	SYMBOL	NAME	VALUE (SI)	UNIT
21	μ_μ	Muon magnetic moment	$-4.4904483 \times 10^{-26}$	J T^{-1}
22	F	Faraday constant (= e·N_A)	$9.648533212 \times 10^{4}$	C mol^{-1}
23	e	Elementary charge (exact)	$1.602176634 \times 10^{-19}$	C
24	N_A	Avogadro constant (exact)	$6.02214076 \times 10^{23}$	mol^{-1}
25	k	Boltzmann constant (exact)	1.380649×10^{-23}	J K^{-1}
26	V_m	Molar volume, ideal gas (273.15 K, 100 kPa)	$2.271095464 \times 10^{-2}$	m^3 mol^{-1}
27	R	Molar gas constant (= k·N_A, exact)	8.31446261815324	J mol^{-1} K^{-1}
28	c	Speed of light in vacuum (exact)	2.99792458×10^{8}	m s^{-1}
29	c_1	First radiation constant (= 2πhc²)	$3.741771852 \times 10^{-16}$	W m^2
30	c_2	Second radiation constant (= hc/k)	$1.438776877 \times 10^{-2}$	m K
31	σ	Stefan–Boltzmann constant	$5.670374419 \times 10^{-8}$	W m^{-2} K^{-4}
32	ε_0	Vacuum electric permittivity	$8.8541878188 \times 10^{-12}$	F m^{-1}
33	μ_0	Vacuum magnetic permeability	$1.25663706127 \times 10^{-6}$	N A^{-2}
34	Φ_0	Magnetic flux quantum (= h/2e)	$2.067833848 \times 10^{-15}$	Wb
35	g	Standard acceleration of gravity (exact)	9.80665	m s^{-2}
36	G_0	Conductance quantum (= 2e²/h)	$7.748091729 \times 10^{-5}$	S
37	Z_0	Characteristic impedance of vacuum	$3.76730313412 \times 10^{2}$	ohm
38	T_0	Ice-point temperature, 0°C (exact)	2.7315×10^{2}	K
39	G	Newtonian constant of gravitation	6.67430×10^{-11}	m^3 kg^{-1} s^{-2}
40	atm	Standard atmosphere (exact)	1.01325×10^{5}	Pa

Values are CODATA 2022 recommended values. Symbols are case-sensitive: g (#35, standard gravity) and G (#39, gravitational constant) are conventionally distinguished only by case.

17 · Constants and Conversions

Two 40-entry indexed pickers, opened with SHIFT+7 and SHIFT+8

#	CONVERSION	MULTIPLY BY	CATEGORY
1	in → cm	2.54	Length
2	cm → in	0.393700787	Length
3	ft → m	0.3048	Length
4	m → ft	3.280839895	Length
5	yd → m	0.9144	Length
6	m → yd	1.093613298	Length
7	mile → km	1.609344	Length
8	km → mile	0.621371192	Length
9	nmi → m	1852	Length
10	acre → m²	4046.8564224	Area
11	oz → g	28.349523125	Mass
12	g → oz	0.035273962	Mass
13	lb → kg	0.45359237	Mass
14	kg → lb	2.204622622	Mass
15	km/h → m/s	0.277777778	Velocity
16	m/s → km/h	3.6	Velocity
17	knot → m/s	0.514444444	Velocity
18	fl oz (US) → mL	29.5735295625	Volume
19	mL → fl oz (US)	0.033814023	Volume
20	gal (US) → L	3.785411784	Volume

17 · Constants and Conversions

Two 40-entry indexed pickers, opened with SHIFT+7 and SHIFT+8

#	CONVERSION	MULTIPLY BY	CATEGORY
21	L → gal (US)	0.264172052	Volume
22	gal (UK) → L	4.54609	Volume
23	L → gal (UK)	0.219969157	Volume
24	pc → km	$3.085677581 \times 10^{13}$	Length
25	cal → J	4.1868	Energy
26	J → cal	0.238845897	Energy
27	kcal → J	4186.8	Energy
28	J → kcal	0.000238846	Energy
29	ft·lbf → J	1.355817948	Energy
30	Btu → J	1055.05585262	Energy
31	hp → kW	0.745699872	Power
32	kgf/cm² → Pa	98066.5	Pressure
33	atm → Pa	101325	Pressure
34	Pa → atm	9.86923×10^{-6}	Pressure
35	mmHg → Pa	133.322387415	Pressure
36	Pa → mmHg	0.007500617	Pressure
37	kgf → N	9.80665	Force
38	lbf → N	4.448221615	Force
39	°F → °C	×5/9, offset −17.777…	Temperature
40	°C → °F	×1.8, offset +32	Temperature

Every row except Temperature is an exact or exactly-derived ratio (see the previous page). Temperature is affine, not a ratio: apply the multiply, then the stated offset.

18 · Error Messages

What each ERROR means, and what to do about it

ERROR	MEANING	WHAT TO DO
Syntax ERROR	The typed characters do not match the grammar — an operator with nothing on one side, a stray symbol, an unmatched closing bracket.	DEL returns the cursor to the fault; retype from there.
Math ERROR	A domain or overflow fault: divide by zero; ln or log of a non-positive number outside CMPLX; asin/acos outside [−1, 1]; a result whose magnitude reaches 1×10^{100}; factorial of a non-integer or of a number above 69; nPr with r > n.	Check the expression is defined for the values used — CMPLX mode relaxes the ln/√ restriction.
Stack ERROR	The expression nests more than 24 parentheses deep, or leaves more than 10 pending values on the evaluator's stack.	Break the calculation into smaller steps, storing intermediate results in A–F or M.
Argument ERROR	A function was given the wrong number of arguments, or an invalid one to Rnd, RanInt, nPr or nCr.	Check the function's arity against the SYNTAX reference and the argument's range.
Range ERROR	Reserved for a value or index outside a permitted range.	Not normally triggered by ordinary use on this model.
Goto ERROR / Time Out	Reserved states inherited from the engine's error model.	Not normally triggered by ordinary use on this model.

DEL after any error returns the entry to the offending point rather than clearing it, so the fault is usually one edit away from fixed.

PART TWO

Formula Handbook

Algebra onwards: the formulas a school and early-university student reaches for most, each with an “On Calcixa” line naming the keys that compute it.

19 · Algebra

Indices, expansion, factorisation, equations, sequences and the binomial theorem

Laws of indices

Multiply, divide	$a^m \cdot a^n = a^{m+n} \quad a^m \div a^n = a^{m-n}$
Power of a power	$(a^m)^n = a^{mn}$
Zero and negative	$a^0 = 1 \quad a^{-n} = \frac{1}{a^n}$
Fractional	$a^{1/n} = \sqrt[n]{a} \quad a^{m/n} = \sqrt[n]{a^m}$
Product/quotient raised	$(ab)^n = a^n b^n \quad (a/b)^n = a^n / b^n$

Surds

Product / quotient	$\sqrt{ab} = \sqrt{a}\sqrt{b} \quad \sqrt{a/b} = \frac{\sqrt{a}}{\sqrt{b}}$
Rationalising a denominator	$\frac{1}{a+\sqrt{b}} \times \frac{a-\sqrt{b}}{a-\sqrt{b}} = \frac{a-\sqrt{b}}{a^2-b}$
Conjugate surd pair	$(a+b\sqrt{c})(a-b\sqrt{c}) = a^2-b^2c$

On Calcixa

Exact surds	SQRT and the SHIFT+SQRT cube root, and SHIFT+POWER n-th root, keep an irrational result as an exact surd wherever possible (Section 5) — $\sqrt{2}$ stays $\sqrt{2}$, it is not rounded to 1.414213562 until S⇔D is pressed.
nth root template	SHIFT+x^ ▫ opens $\sqrt[n]{\ }$ ▫ with both the degree and the radicand editable.

Quadratic and cubic formulas

Quadratic formula	$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
Discriminant	$\Delta = b^2-4ac$: $\Delta>0$ two real roots, $\Delta=0$ one repeated root, $\Delta<0$ a complex conjugate pair.
On Calcixa	EQN mode's Quadratic and Cubic variants (Section 12) solve these directly, real or complex roots alike, without rearranging by hand.

19 · Algebra

Indices, expansion, factorisation, equations, sequences and the binomial theorem

Expansion

Square of a sum/difference	$(a+b)^2 = a^2+2ab+b^2 \quad (a-b)^2 = a^2-2ab+b^2$
Difference of two squares	$(a+b)(a-b) = a^2-b^2$
Cube of a sum/difference	$(a+b)^3 = a^3+3a^2b+3ab^2+b^3$
	$(a-b)^3 = a^3-3a^2b+3ab^2-b^3$

Factorisation

Difference of squares	$a^2-b^2 = (a-b)(a+b)$
Sum/difference of cubes	$a^3+b^3 = (a+b)(a^2-ab+b^2)$
	$a^3-b^3 = (a-b)(a^2+ab+b^2)$
Trinomial by inspection	$x^2+bx+c = (x+p)(x+q)$ where $p+q=b$, $pq=c$

Completing the square

Method	$x^2+bx+c = (x+\frac{b}{2})^2 + (c-\frac{b^2}{4})$
Vertex form	$y = a(x-h)^2+k$ has turning point (h,k)

On Calcixa

Checking a factorisation	Type the expanded form and the factorised form for the same X value with CALC and compare answers — a quick way to check algebra by hand.

19 · Algebra

Indices, expansion, factorisation, equations, sequences and the binomial theorem

Inequalities

Flipping the sign	Multiplying or dividing both sides by a negative number reverses the inequality.
Quadratic inequality	Sketch or sign-chart around the roots of the corresponding equation; the sign of $a(x-p)(x-q)$ alternates at each root.
Absolute value	$\lvert x\rvert < a \Leftrightarrow -a < x < a \quad \lvert x\rvert > a \Leftrightarrow x < -a$ or $x > a$

Partial fractions

Distinct linear factors	$\frac{P(x)}{(x-a)(x-b)} = \frac{A}{x-a} + \frac{B}{x-b}$
Repeated linear factor	$\frac{P(x)}{(x-a)^2(x-b)} = \frac{A}{x-a} + \frac{B}{(x-a)^2} + \frac{C}{x-b}$
Irreducible quadratic factor	$\frac{P(x)}{(x^2+px+q)(x-a)} = \frac{Ax+B}{x^2+px+q} + \frac{C}{x-a}$

Arithmetic sequences

nth term	$a_n = a + (n-1)d$
Sum of n terms	$S_n = \frac{n}{2}(2a+(n-1)d) = \frac{n}{2}(a+l)$

Geometric sequences

nth term	$a_n = ar^{n-1}$
Sum of n terms	$S_n = \frac{a(1-r^n)}{1-r}$, $r \neq 1$
Sum to infinity	$S_\infty = \frac{a}{1-r}$, valid for $\lvert r\rvert < 1$
On Calcixa	Σ (SHIFT+log ▫) sums a fixed number of terms of a sequence typed in X directly, exactly, without a formula — useful as a check.

19 · Algebra

Indices, expansion, factorisation, equations, sequences and the binomial theorem

The binomial theorem

Expansion	$(a+b)^n = \Sigma_{k=0}{}^{n}\, C(n,k)\, a^{n-k}b^k$
General term	$T_{k+1} = C(n,k)\, a^{n-k}b^k$
Pascal's rule	$C(n,k) = C(n-1,k-1) + C(n-1,k)$

On Calcixa

Binomial coefficients	SHIFT+÷ types nCr(directly: nCr(n,k) is C(n,k). SHIFT+× types nPr(for the ordered count $n!/(n-r)!$.

Logarithm laws

Definition	$\log_a x = y \Leftrightarrow a^y = x$
Product, quotient, power	$\log_a(xy)=\log_a x+\log_a y$ $\log_a(x/y)=\log_a x-\log_a y$ $\log_a(x^n)=n\cdot\log_a x$
Change of base	$\log_a x = \dfrac{\log_b x}{\log_b a}$

Exponential equations

Same base	$a^{f(x)}=a^{g(x)} \Rightarrow f(x)=g(x)$
General	$a^x=b \Rightarrow x=\log_a b$
On Calcixa	log(is base 10; the log ▫ (▫) key types any base directly as log□(argument) — no change-of-base arithmetic needed.

20 · Trigonometry

Definitions, exact values, identities, the sine and cosine rules, and inverse ranges

Definitions (right triangle)

sin, cos, tan	$\sin\theta = \frac{\text{opp}}{\text{hyp}}$ $\cos\theta = \frac{\text{adj}}{\text{hyp}}$ $\tan\theta = \frac{\text{opp}}{\text{adj}}$
Reciprocals	$\csc\theta = 1/\sin\theta$ $\sec\theta = 1/\cos\theta$ $\cot\theta = 1/\tan\theta$
Unit circle	$\sin\theta$ and $\cos\theta$ are the y- and x-coordinates of the point at angle θ on the unit circle.

Exact values

0°, 30°, 45°	sin: $0, \frac{1}{2}, \frac{1}{\sqrt{2}}$ cos: $1, \frac{\sqrt{3}}{2}, \frac{1}{\sqrt{2}}$
60°, 90°	sin: $\frac{\sqrt{3}}{2}, 1$ cos: $\frac{1}{2}, 0$
tan	$\tan\theta = \sin\theta / \cos\theta$, so $\tan 45° = 1$ and $\tan 90°$ is undefined.
On Calcixa	In DEG mode, sin, cos and tan of these standard angles return the exact value shown above, not a decimal (Section 5).

DEG / RAD / GRA

Conversion	$180° = \pi$ rad $= 200$ grad
On Calcixa	SHIFT+Ans (DRG▶) cycles the angle unit Deg → Rad → Gra; the D/R/G annunciator always shows which is active.

20 · Trigonometry

Definitions, exact values, identities, the sine and cosine rules, and inverse ranges

Pythagorean identities

Main identity	$\sin^2\theta + \cos^2\theta = 1$
Derived	$1 + \tan^2\theta = \sec^2\theta \quad 1 + \cot^2\theta = \csc^2\theta$

Compound-angle identities

Sine	$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$
Cosine	$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$
Tangent	$\tan(A \pm B) = \dfrac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

Double-angle identities

Sine, tangent	$\sin 2\theta = 2\sin\theta\cos\theta \quad \tan 2\theta = \dfrac{2\tan\theta}{1-\tan^2\theta}$
Cosine (three forms)	$\cos 2\theta = \cos^2\theta - \sin^2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$

Half-angle identities

Sine, cosine	$\sin(\theta/2) = \pm\sqrt{(1-\cos\theta)/2}$ $\cos(\theta/2) = \pm\sqrt{(1+\cos\theta)/2}$
Tangent	$\tan(\theta/2) = \dfrac{1-\cos\theta}{\sin\theta} = \dfrac{\sin\theta}{1+\cos\theta}$

20 · Trigonometry

Definitions, exact values, identities, the sine and cosine rules, and inverse ranges

Sum-to-product

Sines	$\sin A+\sin B = 2\sin\frac{A+B}{2}\cos\frac{A-B}{2}$
	$\sin A-\sin B = 2\cos\frac{A+B}{2}\sin\frac{A-B}{2}$
Cosines	$\cos A+\cos B = 2\cos\frac{A+B}{2}\cos\frac{A-B}{2}$
	$\cos A-\cos B = -2\sin\frac{A+B}{2}\sin\frac{A-B}{2}$

Sine and cosine rules

Sine rule	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$
Cosine rule	$a^2 = b^2+c^2-2bc\cdot\cos A$
Rearranged for an angle	$\cos A = \frac{b^2+c^2-a^2}{2bc}$

Area of a triangle

Two sides and included angle	$\text{Area} = \frac{1}{2}ab\cdot\sin C$
Heron's formula	$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}, s = \frac{a+b+c}{2}$

On Calcixa

Triangle problems	CALC prompts for each side/angle in a typed sine- or cosine-rule expression, in one pass, instead of rearranging by hand.

20 · Trigonometry

Definitions, exact values, identities, the sine and cosine rules, and inverse ranges

Inverse sine

Domain, range	$\sin^{-1}x$: domain $[-1, 1]$, range $[-90°, 90°]$

Inverse cosine

Domain, range	$\cos^{-1}x$: domain $[-1, 1]$, range $[0°, 180°]$

Inverse tangent

Domain, range	$\tan^{-1}x$: domain all reals, range $(-90°, 90°)$

On Calcixa

Inverse keys	SHIFT+sin, SHIFT+cos, SHIFT+tan; hyp first for the inverse hyperbolic forms $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$.
Domain errors	$\sin^{-1}(2)$ is a Math ERROR in COMP; switching to CMPLX mode returns a complex value instead (Section 9).

21 · Coordinate Geometry

Distance, lines, and the four conic sections

Points

Distance	$d = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$
Midpoint	$M = (\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2})$
Gradient	$m = \frac{y_2-y_1}{x_2-x_1}$

Forms of a line

Slope-intercept	$y = mx + c$
Point-slope	$y - y_1 = m(x - x_1)$
General form	$Ax + By + C = 0$

Parallel and perpendicular

Parallel lines	$m_1 = m_2$
Perpendicular lines	$m_1 m_2 = -1$
On Calcixa	Two simultaneous line equations solve directly in EQN mode's 2-unknowns variant (Section 12) — no substitution by hand.

21 · Coordinate Geometry

Distance, lines, and the four conic sections

Circle

Centre-radius form $(x-a)^2 + (y-b)^2 = r^2$

General form $x^2 + y^2 + Dx + Ey + F = 0$

Centre and radius from general form centre $(-D/2, -E/2)$, $r = \sqrt{(D/2)^2+(E/2)^2-F}$

Parabola

Standard form (vertex at origin) $y^2 = 4ax$ — focus $(a, 0)$, directrix $x = -a$

Vertex form $y = a(x-h)^2 + k$ — vertex (h, k)

21 · Coordinate Geometry

Distance, lines, and the four conic sections

Ellipse

Standard form	$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
Foci and eccentricity	foci $(\pm c, 0)$, $c^2 = a^2 - b^2$, $e = c/a < 1$

Hyperbola

Standard form	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$
Foci and asymptotes	foci $(\pm c, 0)$, $c^2 = a^2 + b^2$, asymptotes $y = \pm \frac{b}{a} x$
On Calcixa	A point's distance to a focus, or checking a point lies on a conic, is a direct CALC substitution once the equation is typed.

22 · Mensuration

Perimeter, area, surface area and volume for the shapes that come up most often

Quadrilaterals

Rectangle	$\text{Area} = lw \quad \text{Perimeter} = 2(l+w)$
Square	$\text{Area} = a^2 \quad \text{Perimeter} = 4a$
Parallelogram	$\text{Area} = \text{base} \times \text{height}$
Trapezium	$\text{Area} = \frac{1}{2}(a+b)h$ (a, b the parallel sides)

Triangle

Base and height	$\text{Area} = \frac{1}{2}bh$
Heron's formula	$\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}, s = \frac{a+b+c}{2}$
Perimeter	$a + b + c$

Circle

Area, circumference	$\text{Area} = \pi r^2 \quad \text{Circumference} = 2\pi r$
Sector, arc (angle θ in degrees)	$\text{Sector area} = \frac{\theta}{360}\pi r^2 \quad \text{Arc length} = \frac{\theta}{360}\cdot 2\pi r$
On Calcixa	π is SHIFT+×10ˣ; stays exact through multiplication and division by a rational (Section 5), e.g. 2πr with r=3 prints as 6π.

22 · Mensuration

Perimeter, area, surface area and volume for the shapes that come up most often

Cuboid and cube

Cuboid	$V = lwh \quad SA = 2(lw+lh+wh)$
Cube	$V = a^3 \quad SA = 6a^2$

Cylinder

Volume	$V = \pi r^2 h$
Surface area	$SA = 2\pi r^2 + 2\pi rh = 2\pi r(r+h)$

Sphere

Volume	$V = \frac{4}{3}\pi r^3$
Surface area	$SA = 4\pi r^2$

On Calcixa

Repeated substitution	CALC on a typed volume/area formula prompts for each variable in turn — quicker than retyping the formula for each new radius or height.

22 · Mensuration

Perimeter, area, surface area and volume for the shapes that come up most often

Cone

Volume	$V = \frac{1}{3}\pi r^2 h$
Slant height	$l = \sqrt{r^2+h^2}$
Surface area	$SA = \pi r^2 + \pi r l$

Pyramid

Volume	$V = \frac{1}{3} \times \text{base area} \times h$

Prism

Volume	$V = \text{cross-sectional area} \times \text{length}$

23 · Vectors and Matrices

Components, dot and cross products, determinants, inverses and solving systems

Vector algebra

Addition, subtraction	component-wise: $(a_1,a_2,a_3) \pm (b_1,b_2,b_3) = (a_1 \pm b_1,\ a_2 \pm b_2,\ a_3 \pm b_3)$
Magnitude	$\lvert v\rvert = \sqrt{x^2+y^2+z^2}$
Unit vector	$\hat{v} = v \,/\, \lvert v\rvert$

Dot product

Component form	$a\cdot b = a_1b_1+a_2b_2+a_3b_3$
Angle form	$a\cdot b = \lvert a\rvert\lvert b\rvert\cos\theta$

Cross product (3D)

Formula	$a\times b = (a_2b_3-a_3b_2,\ \ a_3b_1-a_1b_3,\ a_1b_2-a_2b_1)$
Magnitude and area	$\lvert a\times b\rvert = \lvert a\rvert\lvert b\rvert\sin\theta$ = area of the parallelogram spanned by a and b

On Calcixa

VECTOR mode	A+B, A−B, A·B, A×B, |A|, unit A and ∠AB all read straight off the grid (Section 14) — no formula to retype.

23 · Vectors and Matrices

Components, dot and cross products, determinants, inverses and solving systems

Matrix arithmetic

Addition, subtraction	entrywise, matrices must be the same shape
Scalar multiply	k·A multiplies every entry by k
Matrix multiply	$(AB)_{ij} = \Sigma_k A_{ik} B_{kj}$ — the number of columns of A must equal the number of rows of B; AB ≠ BA in general

Determinant

2×2	det = ad−bc, for [[a,b],[c,d]]
3×3	expand along any row or column by cofactors, or use Sarrus' rule

Inverse

2×2	$A^{-1} = \frac{1}{\det A}[[d,-b],[-c,a]]$
Existence	A^{-1} exists only when $\det A \neq 0$

On Calcixa

MATRIX mode	A+B, A−B, A×B, det A, A^{-1}, A^T, rank A and tr A for 2×2, 3×3 and 4×4 (Section 13) — A^{-1} reports "singular" rather than a garbage answer when $\det A \approx 0$.

23 · Vectors and Matrices

Components, dot and cross products, determinants, inverses and solving systems

Cramer's rule (2 unknowns)

System	$a_1x+b_1y=c_1,\ a_2x+b_2y=c_2$
Solution	$x = D_x/D,\quad y = D_y/D$
Determinants	$D=a_1b_2-a_2b_1;\ D_x=c_1b_2-c_2b_1;$ $D_y=a_1c_2-a_2c_1$

On Calcixa

EQN mode	For anything bigger than 2×2, typing the augmented matrix into EQN's simultaneous-system variants and pressing SOLVE (Gaussian elimination with partial pivoting, Section 12) is faster and less error-prone than Cramer's rule by hand — it also reports the determinant.

24 · Complex Numbers

Rectangular and polar forms, De Moivre's theorem, and roots of unity

Rectangular form

Definition	$z = a+bi,\ \ i^2 = -1$
Addition, subtraction	add or subtract the real and imaginary parts separately
Multiplication	$(a+bi)(c+di) = (ac-bd) + (ad+bc)i$
Division	divide by multiplying top and bottom by the conjugate of the denominator

Modulus, argument, conjugate

Modulus	$\lvert z\rvert = \sqrt{a^2+b^2}$
Argument	$\theta = \operatorname{atan2}(b, a)$
Conjugate	$\bar{z} = a-bi$

On Calcixa

CMPLX mode	i (context strip), Abs (modulus), Arg, Conjg all read directly off a computed complex answer (Section 9).

24 · Complex Numbers

Rectangular and polar forms, De Moivre's theorem, and roots of unity

Polar form

Definition	$z = r(\cos\theta + i\sin\theta) = r\angle\theta$
Euler's formula	$z = re^{i\theta}$

Multiplying and dividing in polar form

Product	$r_1\angle\theta_1 \times r_2\angle\theta_2 = r_1r_2\angle(\theta_1+\theta_2)$
Quotient	$r_1\angle\theta_1 \div r_2\angle\theta_2 = (r_1/r_2)\angle(\theta_1-\theta_2)$

De Moivre's theorem

Statement	$z^n = r^n(\cos n\theta + i \sin n\theta)$
On Calcixa	Rec(and Pol(on the context strip convert between the two forms directly; the a+bi ⇄ r∠θ toggle switches how every complex answer is displayed.

24 · Complex Numbers

Rectangular and polar forms, De Moivre's theorem, and roots of unity

Roots of unity and nth roots

nth roots of z	$z^{1/n} = r^{1/n}\angle\frac{\theta+360k}{n}$, $k = 0, 1, \ldots, n-1$
nth roots of unity	$r=1, \theta=0$: n equally spaced points on the unit circle

Worked example (from Section 9)

(2+3i)×(1−i)	$= 5+i$, since $2-2i+3i-3i^2 = 2+i+3 = 5+i$.
In polar form	$\lvert 5+i\rvert = \sqrt{26} \approx 5.0990$, Arg ≈ 11.31° — read directly off the answer with the a+bi ⇄ r∠θ toggle.

25 · Calculus

Limits, standard derivatives and integrals, definite integrals, and series expansions

The derivative, from first principles

Definition	$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$

Standard derivatives

Power, exponential	$x^n \to nx^{n-1}$ $e^x \to e^x$ $a^x \to a^x \ln a$
Logarithm	$\ln x \to 1/x$
Trig	$\sin x \to \cos x$ $\cos x \to -\sin x$ $\tan x \to \sec^2 x$

Rules

Product	$(uv)' = u'v + uv'$
Quotient	$(u/v)' = \frac{u'v - uv'}{v^2}$
Chain rule	$\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$

On Calcixa

d/dx(key	SHIFT+∫ types d/dx(, evaluated numerically at a point by Ridders' extrapolation — d/dx(X^2,3) gives 6. It is not symbolic: it will not hand back "2X" as a formula.

25 · Calculus

Limits, standard derivatives and integrals, definite integrals, and series expansions

Standard integrals

Power rule	$\int x^n dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$
Reciprocal, exponential	$\int \frac{1}{x} dx = \ln\lvert x\rvert + C \quad \int e^x dx = e^x + C$
Trig	$\int \sin x \, dx = -\cos x + C \quad \int \cos x \, dx = \sin x + C \quad \int \sec^2 x \, dx = \tan x + C$
General exponential	$\int a^x dx = \frac{a^x}{\ln a} + C$

On Calcixa

∫ key	Types the three-box definite-integral template (Section 3) and evaluates it numerically by Simpson's rule with X as the variable — it always returns a decimal, never a symbolic antiderivative.

25 · Calculus

Limits, standard derivatives and integrals, definite integrals, and series expansions

The Fundamental Theorem of Calculus

Statement $\int_a^b f'(x)dx = f(b) - f(a)$

Area between two curves

Formula $\text{Area} = \int_a^b [f(x) - g(x)]\,dx$, a to b the intersection points

Volume of revolution

About the x-axis $V = \pi\int_a^b [f(x)]^2\,dx$

About the y-axis $V = \pi\int_c^d [g(y)]^2\,dy$

Worked example (from Section 3)

$\int_0^1 X^2\,dX$ $= 0.3333333333$, matching the exact value $1/3$ to ten decimal places.

25 · Calculus

Limits, standard derivatives and integrals, definite integrals, and series expansions

Taylor series

General form	$f(x) = \Sigma_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!}(x-a)^n$

Maclaurin series (a = 0)

General form	$f(x) = f(0) + f'(0)x + \frac{f''(0)}{2!}x^2 + \ldots$

Standard expansions

e^x	$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$
sin x, cos x	$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots \quad \cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \ldots$
ln(1+x)	$x - \frac{x^2}{2} + \frac{x^3}{3} - \ldots$, valid for $\lvert x \rvert < 1$

On Calcixa

No symbolic engine	Neither ∫ nor d/dx(works symbolically, so a Taylor coefficient $f^n(a)/n!$ must be found by repeated d/dx(calls at the point a, evaluated by hand — Calcixa checks the arithmetic, it does not derive the series.

26 · Statistics and Probability

Descriptive statistics, regression, counting, and the common distributions

Measures of centre

Mean	$\bar{x} = \frac{\Sigma x}{n}$
Median	the middle value of the sorted data (average of the middle two if n is even)
Mode	the most frequently occurring value

Population variance and SD

Variance	$\sigma^2 = \frac{\Sigma(x-\bar{x})^2}{n}$
Standard deviation	$\sigma = \sqrt{\sigma^2}$

Sample variance and SD

Variance	$s^2 = \frac{\Sigma(x-\bar{x})^2}{n-1}$
Standard deviation	$s = \sqrt{s^2}$

On Calcixa

STAT 1-VAR	n, Σx, Σx^2, $\bar{x}$, σx (population) and sx (sample) all come from one grid of data (Section 11) — no running totals by hand.

26 · Statistics and Probability

Descriptive statistics, regression, counting, and the common distributions

Correlation

Pearson's r

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}, \quad -1 \le r \le 1$$

Line of best fit

Least squares

$$y = A+Bx, \quad B = \frac{S_{xy}}{S_{xx}}, \quad A = \bar{y} - B\bar{x}$$

Coefficient of determination

r²

the proportion of the variation in y explained by the fitted model

On Calcixa

STAT regressions

All seven curve types (Section 11: linear, quadratic, logarithmic, exponential, ab^x, power, inverse) fit by least squares and report r directly, plus a ŷ / x̂ estimate button.

26 · Statistics and Probability

Descriptive statistics, regression, counting, and the common distributions

Permutations and combinations

Permutations	${}_{n}P_{r} = \frac{n!}{(n-r)!}$ — order matters
Combinations	${}_{n}C_{r} = \frac{n!}{r!(n-r)!}$ — order does not matter

Probability rules

Addition rule	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Independent events	$P(A \cap B) = P(A) \cdot P(B)$
Conditional probability	$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$
Complement	$P(A') = 1 - P(A)$

On Calcixa

nPr, nCr keys	SHIFT+× and SHIFT+÷; x! is SHIFT+x^{-1}, capped at 69! (Section 1).

26 · Statistics and Probability

Descriptive statistics, regression, counting, and the common distributions

Binomial distribution

PMF $P(X=k) = {}_nC_k p^k (1-p)^{n-k}$

Mean, variance $\mu = np, \quad \sigma^2 = np(1-p)$

Normal distribution

Standardising $Z = \frac{X-\mu}{\sigma}$

Poisson distribution

PMF $P(X=k) = \frac{e^{-\lambda}\lambda^k}{k!}$

On Calcixa

No distribution mode

Calcixa has no dedicated distribution mode; a binomial or Poisson term is typed directly with nCr(, x^y and e^x. STAT's 1-VAR mean and σx are a natural check against a sampled dataset.

27 · Physics and Chemistry Constants

Formulas a calculator user reaches for most, cross-referenced to the CONST table

Mechanics

Newton's second law	$F = ma$
Work, kinetic energy	$W = Fd \quad KE = \frac{1}{2}mv^2$
Gravitational PE	$PE = mgh \quad (g = \text{CONST } \#35)$
Momentum	$p = mv$

Thermal and gas laws

Ideal gas law	$PV = nRT \quad (R = \text{CONST } \#27)$
Molar volume at STP	$V_m = \text{CONST } \#26$

Electromagnetism

Coulomb's law	$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \quad (\varepsilon_0 = \text{CONST } \#32)$
Mass–energy equivalence	$E = mc^2 \quad (c = \text{CONST } \#28)$

On Calcixa

CONST picker	SHIFT+7 then the index number inserts the constant's symbol with its exact value already attached — no need to retype 9.80665 or 6.022×10^{23} by hand.

27 · Physics and Chemistry Constants

Formulas a calculator user reaches for most, cross-referenced to the CONST table

EVERYDAY CONSTANT	CONST INDEX	SYMBOL
Standard gravity	#35	g
Speed of light	#28	c
Planck constant	#6	h
Elementary charge	#23	e
Boltzmann constant	#25	k
Avogadro constant	#24	N_A
Molar gas constant	#27	R
Gravitational constant	#39	G
Vacuum permittivity	#32	ε_0
Vacuum permeability	#33	μ_0
Standard atmosphere	#40	atm
Ice-point temperature (0°C in K)	#38	T_0
Electron mass	#3	m_e
Proton mass	#1	m_p
Neutron mass	#2	m_n

Full 40-entry tables for CONST and CONV are in Section 17. Relevant CONV categories for physics and chemistry work: Energy (cal, kcal, J, Btu, ft·lbf), Pressure (atm, Pa, mmHg, kgf/cm²) and Force (kgf, lbf, N).

Keep this handy.

- The full keypad, SHIFT and ALPHA legends, and how True-Form entry walks into a fraction, root or power.
- All eight modes — COMP, CMPLX, BASE-N, STAT, EQN, MATRIX, VECTOR, TABLE — each with a worked, verified example.
- The full 40-entry CONST and CONV tables, generated straight from the app’s own data.
- Algebra, trigonometry, coordinate geometry, mensuration, vectors and matrices, complex numbers, calculus, statistics and probability — each cross-referenced to the keys that compute it.

Every statement about the app in Part One was checked against the Calcixa source (Keys.kt, CalculatorController.kt, Workspace.kt, ContextActions.kt, the engine package and its tables) rather than assumed. Where the source did not settle a detail, it was left out rather than guessed.