

Equation Pad

User guide

The engineering calculation tool

YOUR LOGO	PROJECT Your project				JOB NO. 00-001	SHEET 1 of 1
	CALCULATION FOR Getting started					REVISION 0
	CALCULATED BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

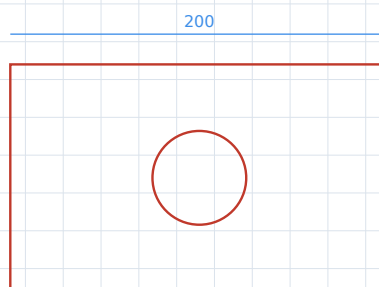
$$v := d / t = 80 \text{ km/h}$$

$$\int_0^2 f(x) dx = 6$$

$$C := [A, b] = \begin{bmatrix} 4 & -2 & 2 \\ 1 & 1 & 3 \end{bmatrix}$$

$$total \leq budget = \text{TRUE}$$

+



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START HERE

Equation Pad starts with an empty sheet. The first time, a small card offers the short example sheet “Feature tour”; you can open it any time with **Help ► Open the Feature tour example**. The fastest way to learn is to double-click its lines and change the numbers. Most examples in this guide come from that sheet.

CHAPTER 1

Introduction

Equation Pad is a professional calculation tool for engineers and technical professionals. You write equations the way you would on paper, with real units, every answer updates the moment an input changes, and the result is a set of checked calculation sheets that are ready to issue. It runs in your web browser.

What it is used for

- **Structural calculations:** loads, actions, member checks and design to your code, set out like a hand calculation that a checker can follow line by line.
- **Numerical problem solutions:** equations, roots, systems of equations, integrals, derivatives, sums and differential equations, all with units.
- **Matrix operations:** inverse, determinant, transpose, eigenvalues, block matrices and linear systems.
- **Spreadsheet and sketching tool combined with the calculator:** a spreadsheet, a 2D/3D drawing editor and a free-hand drawing board live on the same sheet as the maths and feed into it.
- **And so on:** graphs, unit conversion, short programs and any other calculation that has to be shown, checked and signed.

What you can do with it

- **Live maths with units.** Define values such as 120 km or 1.5 h, combine them, and ask for the answer in any compatible unit.
- **Calculus and matrices.** Definite integrals, derivatives, sums, matrix algebra, solving linear systems and joining matrices into blocks.
- **Solving and graphs.** Roots of functions, equations and systems of equations, differential equations, symbolic simplify and expand, and line graphs with a hover read-out.
- **Program blocks.** Short calculations with if, else, for and while, written as plain lines and shown as a neat block on the sheet.
- **Collapsible areas, notes and step-by-step presentation** to keep long worksheets tidy and to walk people through them.
- **Free placement on real paper.** Click anywhere on an A4, A3, A5, Letter or Legal sheet and start typing. Content flows onto new sheets as it grows.
- **Professional sheets.** Every sheet carries a title block with your company logo, project details and sign-off boxes, a configurable grid, and a footer with sheet numbers.
- **Rich text.** Fonts, sizes, colours, highlight, bold, italic, underline, strikethrough, alignment, bullets, numbering and indents.
- **Spreadsheets.** Formulas, units, click-to-reference cells, cell formatting and your worksheet variables. Any cell can feed a maths line, and a whole spreadsheet can be used as a matrix.
- **CAD drawings and sketches.** A 2D/3D drawing editor with typed commands, dockable toolbars, snaps, layers, dimensions and hatching, and a drawing board for free-hand sketches.
- **Files for others.** PDF, .docx documents, .xlsx workbooks and .csv files, made in your browser.
- **Help when you need it.** Ask the built-in assistant “how do I...?” in your own words.
- **Private by design.** Everything runs in your browser. We never see or store your calculations.

New in version 1.3.0

Change	Where to read more
Matrices are typed in a grid of boxes between brackets; a matrix already in a line opens in the grid	Matrices
Bold, italic, underline, strikethrough, colour, highlight and size on maths lines; on selected text blocks for all their text	Writing maths, Text
A new line with a word, a space and another word turns into text (a line starting with (stays maths)	Writing maths
A dot inside a subscript is part of the name: $A_{s.req}$, $f_{c.k}$, $b_{eff.1}$	Writing maths
Spreadsheets: picked cells get a moving dotted border; F4 cycles A5, \$A\$5, A\$5, \$A5	Spreadsheets
Animated pictures in the tips of the right-hand panel show how each maths function works	The window
A one-minute animated tour, offered when the app opens (until you say no) and in Help ► Animated tour	How to open it
Bright colour themes: Rainbow, Neon pop, Candy, Tropical, Citrus, Sunrise, Electric lime	The window
The Arrange toolbar is shown at first; Show key presses is on at Extra large; the feedback card comes every five minutes	The window, Keyboard shortcuts
Dragging near a picture no longer selects the letters of other regions	Placing and arranging regions

New in version 1.2.1

Change	Where to read more
Change case (UPPERCASE, lowercase, Sentence case, Capitalize Each Word, camelCase...) and one-size-bigger / smaller buttons; icons in the Text menus	Text
Show key presses: also what you type, shortcuts shown as Ctrl+T, and four sizes	Keyboard shortcuts
Drawing editor: lines also by pressing, dragging and releasing; each new segment starts at the last end point	Drawings
The “How do you feel” card came back every two minutes until it was sent (five minutes from 1.3.0)	The window

New in version 1.2.0

Change	Where to read more
Phrase suggestions while typing text: about 30 000 engineering phrases, Tab takes one, and your own phrases are learnt	Text
A keyboard shortcut for every command: Alt+Shift shortcuts, menu letters after tapping Alt, Ctrl+/ to find a command, and your own shortcuts	Keyboard shortcuts
View ► Show key presses: a label for every shortcut and click, in the colours of the theme	Keyboard shortcuts
Drawing editor: a menu bar, and Properties, Layers, Snaps and Hatch windows that dock or float	Drawings
Drawing editor: C closes a shape only once it has two segments; after Esc, Enter twice goes on from the last point	Drawings
A new text block starts about ten characters wide and grows as you type; a cell being edited stays inside its cell	Text, Spreadsheets

New in version 1.1.0

Change	Where to read more
A spreadsheet editor in its own full-screen window: tabs, fill handle, copy and paste, undo, sort, filter, freeze, number formats, borders and more than a hundred functions	Spreadsheets
Graph types (line, line + points, points, bars, area, steps, polar, parametric) and Graph settings: axes, grid, scale, labels, colours, line style and fill	Graphs
Heading 1 to Heading 5, and styles that apply to the whole worksheet (Format ► Styles)	Text
Clear rules: " as the first key gives a text block, any other key a maths line; a maths line stays maths and a text block stays text	Text
Spelling check in text blocks, done by the browser (Format ► Check spelling while typing)	Text
Tips for the tool in use at the top of the right-hand panel	The window
Join text and values: "I have taken " + x + " apples." =	Writing maths
= ?n shows exactly n decimal places, also with a unit: = ?4 kN	Writing maths
g is standard gravity, 9.80665 m/s ² , like e and π	Writing maths
TRUE and FALSE stay inside their green and red tags	Functions, calculus and logic
Only the logo in the title bar; it opens the home page in a new tab	The window

New in version 1.0.0

Change	Where to read more
Two pages side by side (View menu or the button next to the zoom)	The window
Typing " at the start of a new maths line turns it into text (replaced in 1.1.0: " is a text block only as the first key)	Your first worksheet, Text
The Feature tour example no longer opens by itself; a small welcome card offers it, and Help ► Open the Feature tour example opens it any time	The window
The Equation Pad logo opens the home page in a new tab	The window
On phones and narrow windows the toolbars step aside: the menu bar has every command	The window
"Before you go" card: tell us how you feel and join the waitlist for a 20% early-bird discount	The window
Help ► About shows how often Equation Pad has been opened worldwide and the total time spent in it	The window

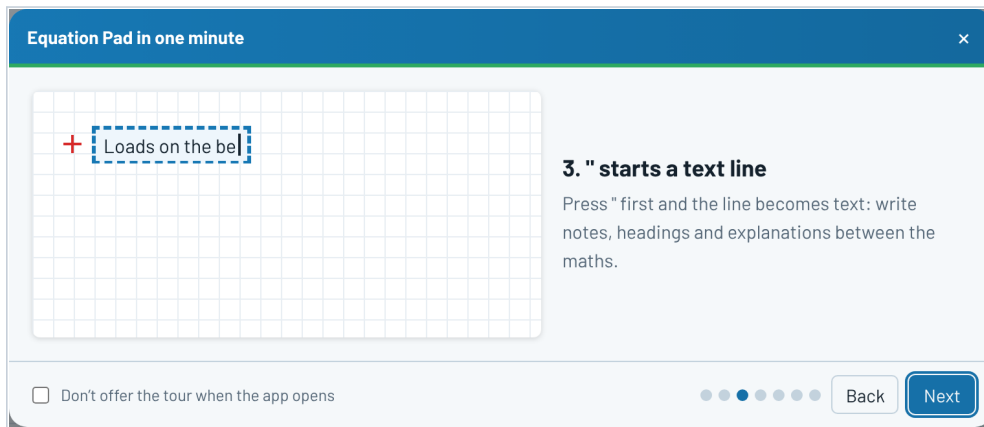
New in version 0.0.7

Change	Where to read more
Long lines also wrap inside summation, integrals, brackets and long function calls	Writing maths
Several regions copy and paste exactly as they are, also into another tab	Your first worksheet
First run shows only the Standard and Insert toolbars, and Text formatting below them	The window
A light "beta version" line down the right margin of printouts, PDFs, web pages and .docx	Files, printing and export
Clear browser data; a new tab no longer carries another tab's worksheet	Files, printing and export
File ► Cloud: all four items work now (direct saving once switched on)	Files, printing and export
Send feedback: how do you feel, 0 to 5	The window
A toolbar reference: every button explained	Toolbar reference
A complete programming chapter, and programs written the Python way	Programming
Every SI prefix from quecto to quetta, μ and Ω , and more units (Nm, lx, Bq, Gy, kat...)	Units
Drawing editor: Layer Properties, a Hatch panel with pattern pictures, a scrollable command history, and Annotate, Drafting and Layers hidden at first	Drawings

How to open it

Go to **www.equationpad.com** in Chrome, Edge, Firefox or Safari. There is nothing to install. Your current worksheet is kept as a draft in the browser while you work. To keep a worksheet for good, save it as a file (File ► Save) or to your own Google Drive or OneDrive (File ► Cloud); worksheet files end in **.eqnpad** and can be opened again on any computer.

The animated tour. When the app opens on an empty sheet, a small card offers a one-minute animated tour: it shows on a little sheet of its own how a maths line is typed, how = shows a value, how " starts a text line, and how units, graphs, matrices, saving and PDF work. Your own work is never touched. Tick **Don't show this again** to stop the card; the tour is always in **Help ► Animated tour**, and the website links to it.



One scene of the animated tour: " starts a text line.

YOUR CALCULATIONS STAY YOURS

Equation Pad does all its work inside your browser. Your worksheets are never sent to us: they stay on your computer, in files you save, or in your own cloud drive.

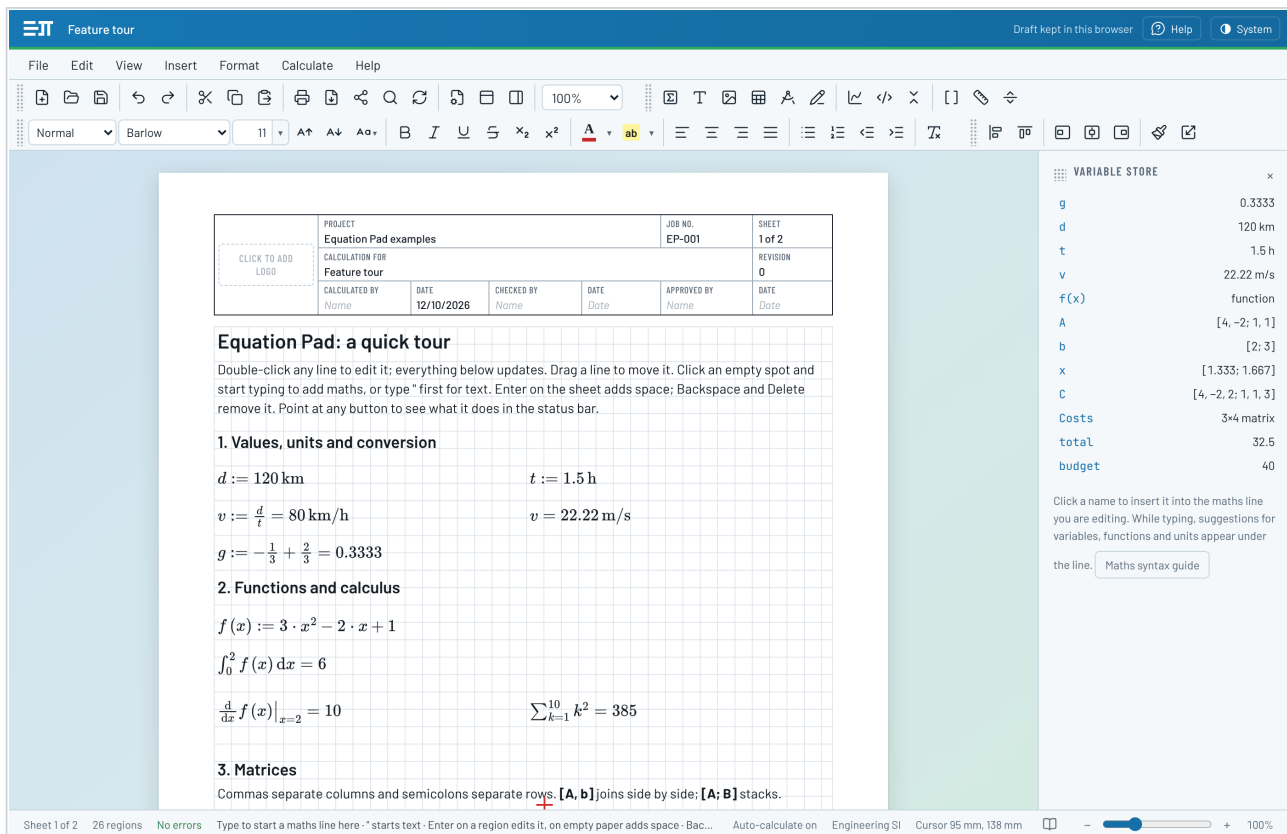
The words used in this guide

Term	Meaning
Sheet	One printed page of the worksheet, with its title block and footer.
Region	One item on a sheet: a maths line, a text block, a spreadsheet, a picture, a drawing or a page break.
Cursor (red cross)	Where the next region will be placed. Click an empty spot on a sheet to move it.
Variable	A named value, such as d or x_1 , defined with $:=$ (or $=$ for a new name) and usable anywhere below.
Toolbar	A strip of buttons. Toolbars can be docked on any side of the sheet area, floated or hidden.

CHAPTER 2

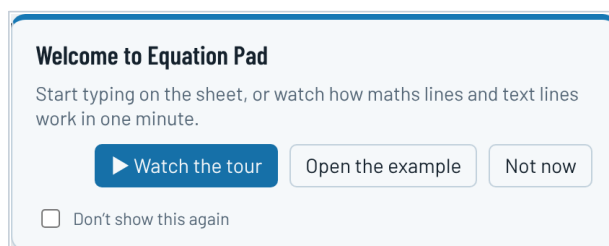
The window

The window looks like a desktop program: a title bar, a menu bar, toolbars, the sheets in the middle, the variable store on the right and a status bar along the bottom.



The Equation Pad window with the example sheet open.

The very first time, Equation Pad opens with an empty sheet and a small welcome card. **Open the feature tour** loads the example sheet; **Start empty** closes the card. The card does not come back, and the example is never put in place of your work: after a browser's data has been cleared you simply start with an empty sheet again. Open the example any time with **Help ► Open the Feature tour example** (Undo brings your own sheet back).



The welcome card on a first visit.

Part	What it does
Title bar	Click the logo at the left to open the home page, www.equationpad.com , in a new tab (your worksheet stays open). The title bar shows the name of the calculation (taken from the "Calculation for" box of the title block), the file name, and a dot when there are unsaved changes. The Help button opens the "How do I...?" assistant; the theme button switches between system, light and dark.

Part	What it does
Menu bar	Every command, grouped in File, Edit, View, Insert, Format, Calculate and Help. Items with ► open a submenu.
Toolbars	Standard, Insert, Arrange, Text formatting, Maths and Spreadsheet. See the next section.
Sheets	The paper. Click to place the cursor, then type.
Variable store	Every variable and function defined so far, with its current value. Click a name to insert it into the maths line or spreadsheet cell you are typing in. At its top, a tip explains the tool you are using (see below). Close it with ×, drag its title to dock it left or right or to float it, and bring it back with View ► Variable store.
Status bar	Sheet number, number of regions, errors (click to jump to the first one), a hint line, calculation mode, unit system and the zoom slider.

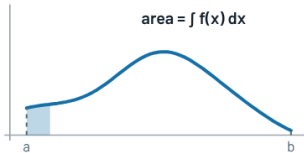
Tips for the tool you are using

Select a maths line, or type in one, and the top of the variable store explains the tool it uses: integrate, diff, summation, root, solve, ode, plot, a matrix, simplify, a check and so on, with the way to write it, what it does and an example. Click the example to insert it. A spreadsheet, a program block, a drawing or a text block shows its own tip. For maths functions the tip also has a small looping animation of how the function works: the area under the curve filling in for integrate, a tangent sliding along the curve for diff, bars adding up for summation, the search closing in on a root, two curves meeting for solve, the rows of a matrix turning into columns for transpose, and so on. With reduce motion switched on in your system, the pictures stand still.

VARIABLE STORE

✕

TIP · INTEGRAL



$\text{area} = \int f(x) \, dx$

`integrate(f(x), x, a, b)`

Definite integral of f from a to b.
Both limits need the same units;
the result carries the units of f
times x.

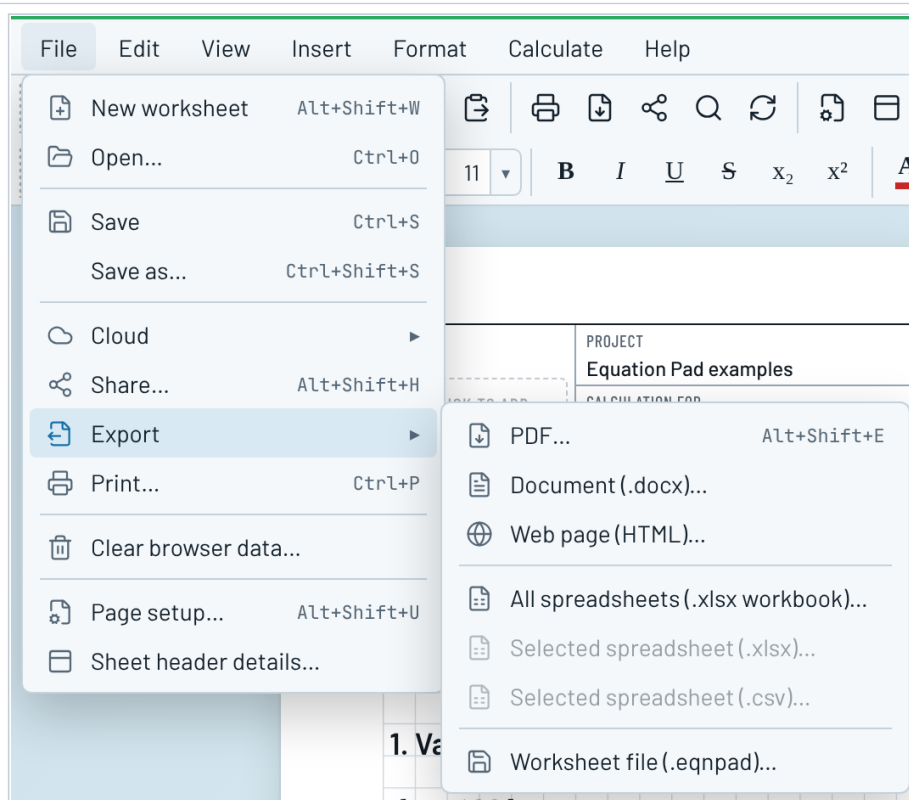
`integrate(3*x^2, x, 0, 2)`
`=`

g	0.3333
d	120 km
t	1.5 h
v	22.22 m/s

The tip for an integral, with its animation, above the variables.

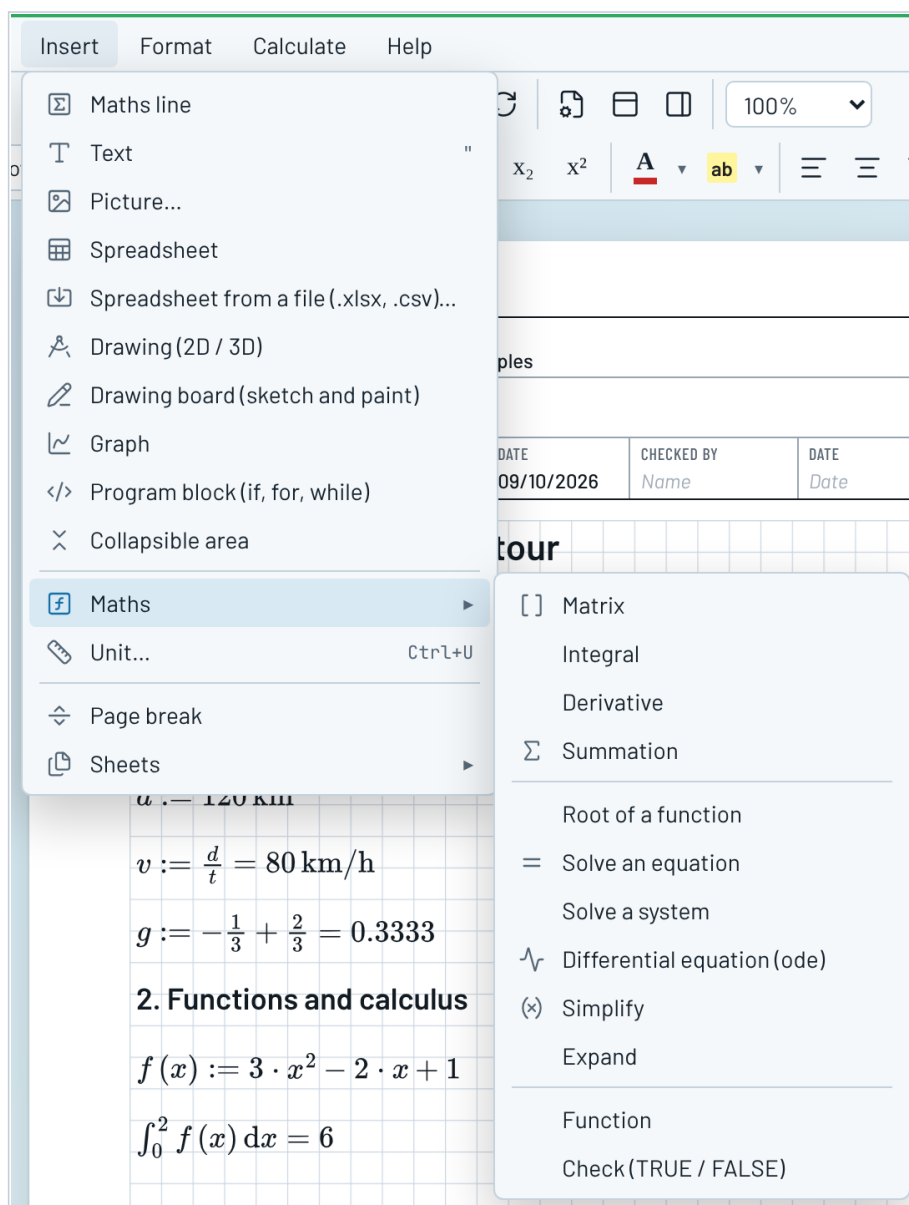
The menus

Menu	What is in it
File	New, Open, Save, Save as · Cloud ► Google Drive, OneDrive · Share · Export ► PDF, document (.docx), web page (HTML), spreadsheets (.xlsx, .csv), worksheet file · Print · Clear browser data · Page setup, Sheet header details.
Edit	Undo, Redo · Cut, Copy, Paste, Delete, Select all · Find, Replace · Space ► insert or remove space at the cursor.
View	Zoom ► · Two pages side by side · Toolbars ► · Variable store, Variable store position ► · Grid, Grid settings · Step-by-step presentation · Colour themes · Light / dark ►.
Insert	Maths line, Text, Picture, Spreadsheet, Spreadsheet from a file, Drawing, Drawing board, Graph, Program block, Collapsible area · Maths ► matrix, integral, derivative, sum, root, solve, system, ode, simplify, expand, function, check · Unit · Page break · Sheets ►.
Format	Text ► · Paragraph ► · Styles... · Check spelling while typing · Lists and indents ► · Arrange regions ► align, margins, centre, match properties, reset size · Result format and units · Page setup.
Calculate	Recalculate now, Calculate automatically · Go to first error · Units ► · Result format.
Help	How do I...? (F1) · Maths syntax guide, Keyboard shortcuts, Units list · User guide (PDF) · Animated tour · Open the Feature tour example · Send feedback · Clear browser data · About.



File ► Export opens a submenu: PDF, .docx document, web page, spreadsheets as .xlsx or .csv, or the worksheet file.

Menu items carry the same icons as the toolbar buttons, so a command is easy to find in either place.

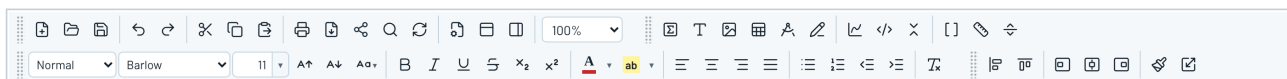


Insert ► Maths: templates for matrices, calculus, solving and symbolic maths.

Right-click a region (a maths line, text block, program, area and so on) for a short menu: cut, copy, delete, edit, Arrange ►, plus the commands for that kind of region, such as Collapse area, Result format for this line and Add a note.

Every window that opens (Page setup, Share, Units, Help and the others) can be moved: drag it by its title bar.

The six toolbars



The toolbars a new user sees: Standard and Insert on the first row, Text formatting and Arrange on the second. Maths and Spreadsheet are added from View ► Toolbars.

Toolbar	Contents
Standard	New, Open, Save · Undo, Redo · Cut, Copy, Paste · Print, Save as PDF, Share, Find, Recalculate · Page setup, Sheet header details, Variable store · Zoom.

Toolbar	Contents
Insert	Maths line, Text, Picture, Spreadsheet, Drawing, Drawing board · Graph, Program block, Collapsible area · Matrix, Unit, Page break.
Arrange	Align left edges, align tops · left margin, centre on the sheet, right margin · Match properties, reset size to 100%.
Text formatting	Paragraph style, font, size · Bold, Italic, Underline, Strikethrough, Subscript, Superscript · Text colour, Highlight · Align left, centre, right, justify · Bullets, numbering, indent · Clear formatting.
Maths	The three equals signs ($\coloneqq$ define, $=$ calculate, $\square$ plain) and checks ($\leq$, $\geq$, $\neq$, $?$:) · powers and roots · integral, derivative, sum · matrix tools, including join [A,B] and stack [A;B] · Greek letters.
Spreadsheet	Name, header row · add or delete rows and columns · column width · copy a cell reference · Format ▼ with all spreadsheet options · Import..., .xlsx..., .csv... files.

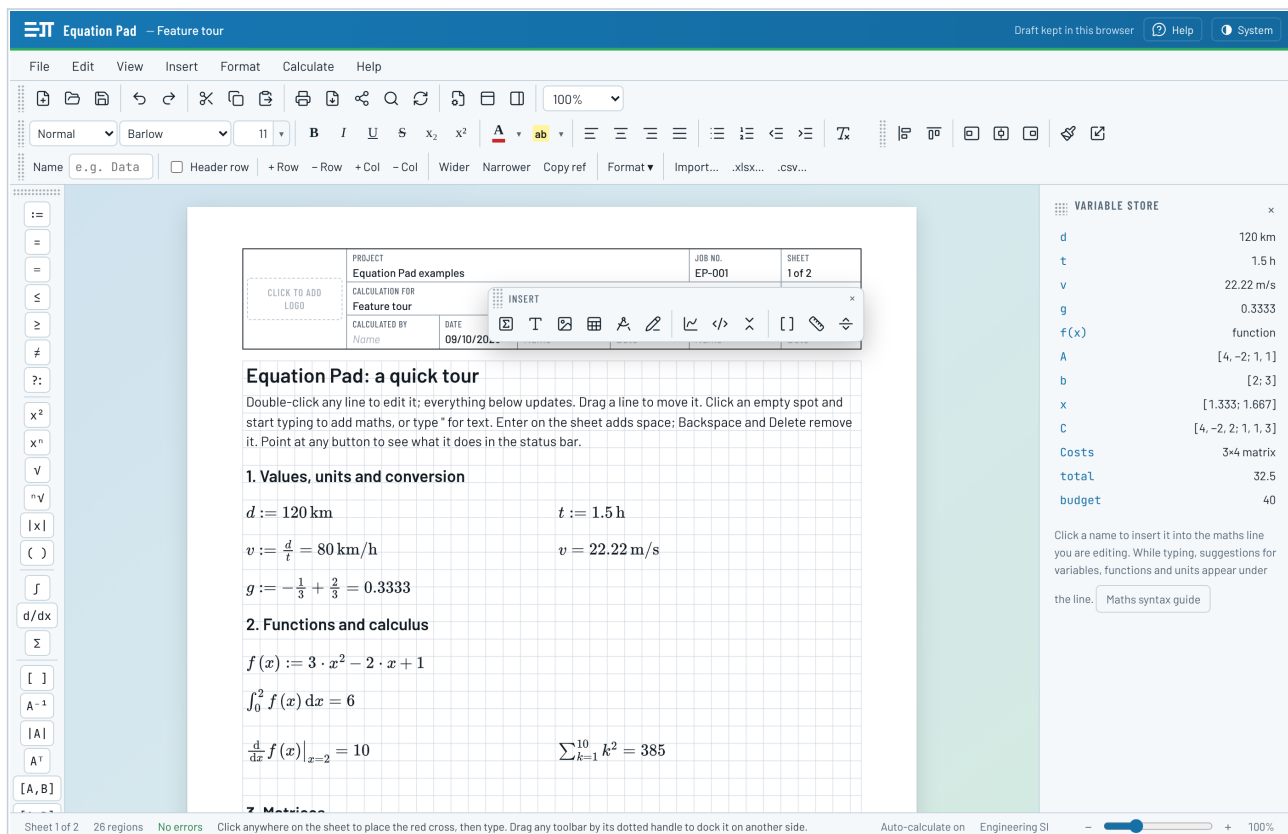
The first time Equation Pad opens, the **Standard** and **Insert** toolbars are shown, with **Text formatting** and **Arrange** on a second row (on a phone, Arrange is hidden). Add Maths and Spreadsheet from **View ► Toolbars** (or right-click any toolbar). Every button is explained in the next chapter.

TIP

The toolbar that matches what you are doing is tinted: Text formatting while you type text, Spreadsheet while a spreadsheet is selected, Maths while you edit a maths line. Point at any button and the status bar explains it.

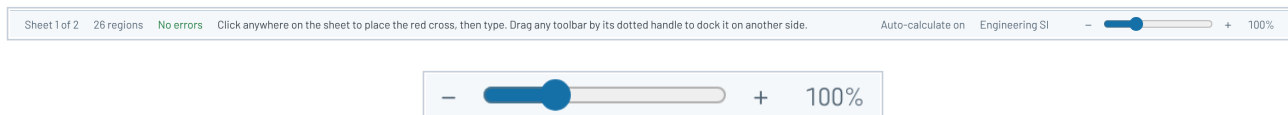
Moving, docking and hiding toolbars

- **Move:** drag a toolbar by its dotted handle at the left (or top) edge.
- **Dock:** drop it near the top, bottom, left or right edge of the sheet area. The edge that will take it is highlighted while you drag. Toolbars docked left or right turn vertical.
- **Float:** drop it anywhere else and it becomes a small floating window with its own title. Double-click the handle to switch between floating and docked.
- **Hide:** click the × at the end of the toolbar.
- **Bring back:** View ► Toolbars, or right-click any toolbar or the menu bar. **Reset toolbar layout** puts everything back where it started.
- The layout is remembered in this browser.



The Maths toolbar docked on the left; the Insert toolbar floating over the sheet.

The status bar

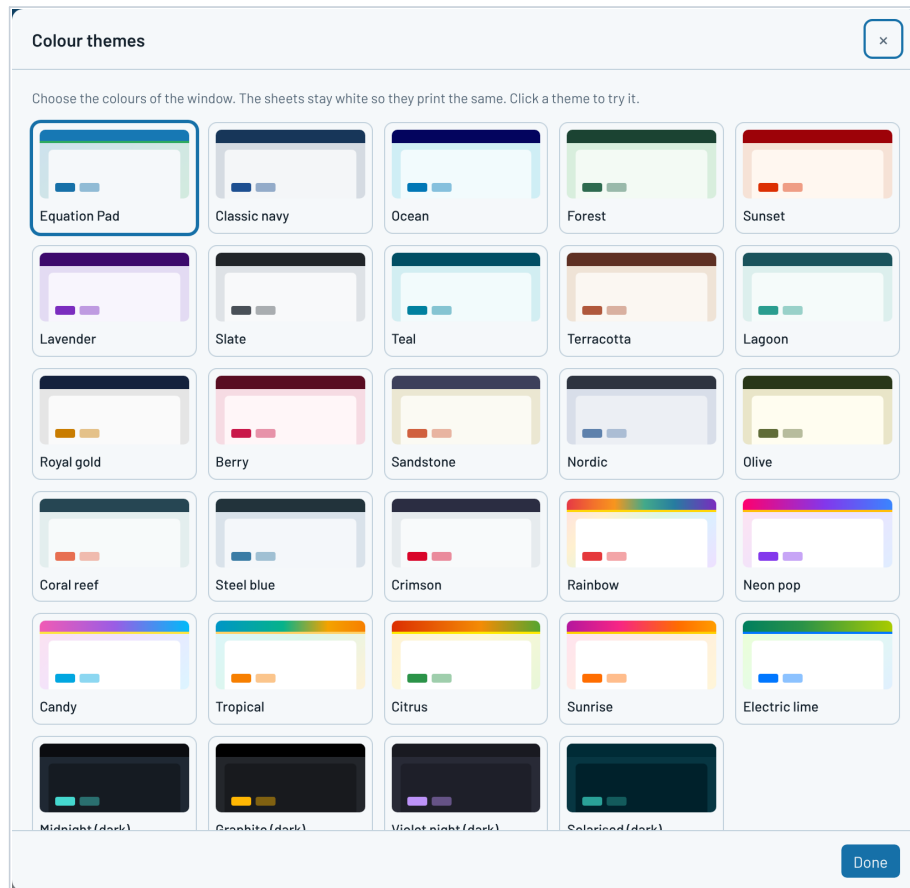


The zoom slider at the right of the status bar.

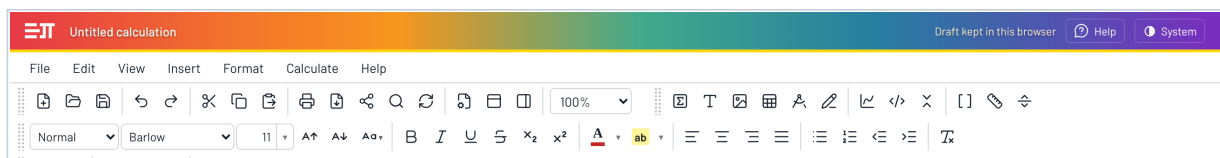
Drag the slider, click – or +, or hold Ctrl and turn the mouse wheel to zoom from 25% to 300%. Click the percentage to switch between fit-to-width and 100%.

Colour themes

View ► Colour themes offers 29 colour schemes for the window: light, dark and bright. The bright ones (Rainbow, Neon pop, Candy, Tropical, Citrus, Sunrise and Electric lime) have a coloured gradient title bar and a soft coloured desk. The first, **Equation Pad**, uses the blue and green of the logo and is the standard look. Click one to try it; the choice is remembered in this browser. The sheets themselves stay white, so printing is not affected. **View ► Light / dark** switches between the standard light and dark looks.



View ► Colour themes.



The Rainbow theme.

The middle of the status bar is a running hint. It tells you what the keys do in the place you are working: on the sheet, in a maths line, in a text block, in a spreadsheet cell or a formula, or in the title block. When you point at a button, it shows what that button does.

Two pages side by side

Choose **View ► Two pages side by side**, or click the book button just left of the zoom slider, to see two sheets next to each other, like an open report. The zoom changes to fit both pages across the window; everything else works as usual. Click the button again for one page at a time. The choice is remembered in this browser. On a narrow screen one page is shown.

The screenshot displays the Equation Pad software interface with two sheets side-by-side. The top menu bar includes File, Edit, View, Insert, Format, Calculate, and Help. Below the menu is a toolbar with various icons for editing and calculation. The left sheet, titled 'Equation Pad examples', contains sections for 'Equation Pad: a quick tour', '1. Values, units and conversion', '2. Functions and calculus', '3. Matrices', and '4. Tables and checks'. The right sheet, titled 'Equation Pad examples', contains a 'Costs' table, a drawing of a plate with a hole, and a 'Variable Store' panel on the right. The 'Variable Store' panel lists variables like d, t, v, g, f(x), A, b, x, C, Costs, total, and budget with their respective values and units. The bottom status bar shows 'Sheet 2 of 2', '26 regions', 'No errors', and 'Auto-calculate on'.

Two sheets side by side.

On a phone or a narrow window

When the window is narrower than about 900 pixels (most phones and small tablets), the toolbars are hidden to leave the room for the sheet. Every command is still in the menu bar: File, Edit, View, Insert, Format, Calculate and Help. Widen the window and the toolbars come back where you left them.

Telling us how you feel, and the waitlist

Help ► Send feedback opens a small card: how do you feel about Equation Pad, from 0 (not at all happy) to 5 (very happy), with room for a comment. Below it, until you have joined, the card asks: *Do you enjoy using it?* Then it may be worth joining the waitlist now, for an exclusive **20% early-bird discount** when Equation Pad launches on 1 January 2027. Type your name and email address and click **Send / join**. You can send a rating, join the waitlist, or both.

Until you have sent it, the card comes back every five minutes, quietly in the corner (it does not take the keyboard away from your work), and also when you are about to leave Equation Pad: when you move the pointer up to the tabs or the close button, when you click the tab's **x**, close the window or reload (the browser first asks whether to leave the site; choose **Stay** and the card is there), and when you press the browser's **Back** button. **Not now** or **x** puts it away for five minutes. Once you send a rating or join the waitlist, it stays away for the rest of the session.

Only your rating, what you type and, if you join, your name and email are sent, never your worksheet. **Email us instead** opens an email to eqn.pad@gmail.com for anything longer.

Before you go: how do you feel about Equation Pad?

0 = not at all happy, 5 = very happy

0

1

2

3

4

5

More worked examples for retaining walls, please.

Do you enjoy using it?

Then it may be worth joining the waitlist now: you get an exclusive **20% early-bird discount** at launch on 1 January 2027.

We use your email only to tell you about the launch and your offer. See the [privacy policy](#).

[Email us instead](#)

Only your rating, what you type and, if you join, your name and email are sent. Your worksheet never is.

The “Before you go” card with the waitlist form.

About Equation Pad

Help ► About shows the version, what Equation Pad is for, the licences of the parts it is built with and how to reach us.

About Equation Pad



Equation Pad
Version 1.1.0

The engineering calculation tool: structural calculations, numerical problem solutions and matrix operations, with a spreadsheet and a drawing board built into the calculator. Live maths with units, solving, graphs, pictures and drawings on calculation sheets that are ready to issue.

We never see or store your calculations. Everything runs in this browser. Your work stays on this computer, in files you save, or in your own Google Drive or OneDrive.

Results must be checked by a competent person before they are relied on. See the [disclaimer](#), [terms](#) and [privacy policy](#).

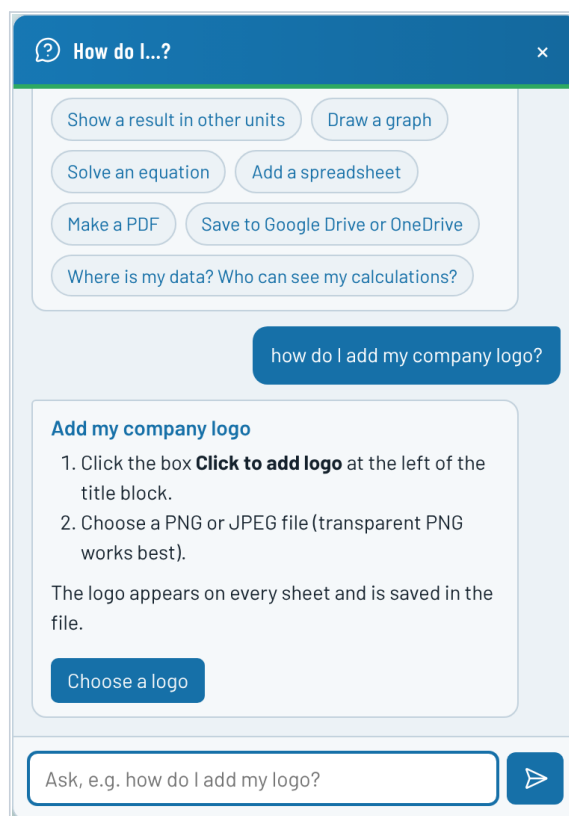
Built with math.js and MathJax (Apache 2.0), three.js (MIT), Lucide icons (ISC), and the Barlow and JetBrains Mono fonts (SIL Open Font License).

Contact: eqn.pad@gmail.com · [equationpad.com](#)

Help ► About.

Asking for help: “How do I...?”

Click **Help** at the top right of the window, choose **Help ► How do I...?** or press **F1**. A small panel opens. Type a question in your own words, such as “add my logo”, “convert km/h to m/s” or “make a PDF”, and press Enter. The answer shows the steps, often with a button that does the job for you, and suggests related topics.



The help assistant answering a question.

The assistant is not an AI and needs no internet connection: it looks your question up in this guide, inside your browser, and nothing you type is sent anywhere. If it cannot find an answer, try other words or pick one of the suggested topics. Drag the panel by its title to move it; Esc or × closes it.

CHAPTER 3

Toolbar reference

Every button of every toolbar, with what it does. Point at a button in the app and the status bar shows the same explanation. Toolbars can be docked on any side, floated or hidden (chapter 2).

Standard toolbar

Button	Name	What it does
	New worksheet	New worksheet
	Open...	Open... (Ctrl+O)
	Save	Save (Ctrl+S)
	Undo	Undo (Ctrl+Z)
	Redo	Redo (Ctrl+Y)
	Cut	Cut (Ctrl+X)
	Copy	Copy (Ctrl+C)
	Paste regions	Paste regions (Ctrl+V)
	Print	Print (Ctrl+P)
	Save as PDF	Save as PDF
	Share by email, WhatsApp...	Share by email, WhatsApp...
	Find and replace	Find and replace (Ctrl+F)
	Recalculate	Recalculate (F9)
	Page setup	Page setup: paper, margins, grid, title block
	Sheet header details and logo	Sheet header details and logo
	Show or hide the variable store	Show or hide the variable store

Insert toolbar

Button	Name	What it does
	Maths line	Maths line (or click the sheet and just type)
	Text	Text (or type " on the sheet)
	Picture...	Picture...
	Spreadsheet	Spreadsheet
	Drawing	Drawing (2D / 3D)
	Drawing board	Drawing board: sketch and paint
	Graph	Graph: plot(f(x), x, a, b)
	Program block	Program block (if, for, while)
	Collapsible area	Collapsible area
	Matrix	Matrix (type over the template; add rows with ; and columns with ,)
	Unit...	Unit... (Ctrl+U)
	Page break	Page break

Arrange toolbar

Button	Name	What it does
	Align left edges	Align left edges: the selected regions line up in one column
	Align tops	Align tops: the selected regions line up in one row
	Left margin	Move the selected regions to the left margin
	Centre on the sheet	Centre the selected regions on the sheet
	Right margin	Move the selected regions to the right margin
	Match properties	Match properties: select a region, click this, then click the regions that should get the same size and format
	Reset size to 100%	Reset size to 100%

Text formatting toolbar

The boxes at the start set the **paragraph style** (Normal, Heading 1 to Heading 5, Quote), the **font** and the **size** in points: pick one with ▼, type any size and press Enter, or turn the mouse wheel over the box. With text selected the change applies to the selection; with just the cursor in a word, to that word.

Button	Name	What it does
	Bigger text	Bigger text: one size up (Ctrl+])
	Smaller text	Smaller text: one size down (Ctrl+[)

Button	Name	What it does
	Bold	Bold (Ctrl+B)
	Italic	Italic (Ctrl+I)
	Underline	Underline (Ctrl+U)
	Strikethrough	Strikethrough
	Subscript	Subscript
	Superscript	Superscript
	Text colour	Text colour (click ▼ to choose another)
	Text colour	Text colour (click ▼ to choose another)
	Highlight colour	Highlight colour (click ▼ to choose another)
	Highlight colour	Highlight colour (click ▼ to choose another)
	Align left	Align left
	Centre	Centre
	Align right	Align right
	Justify	Justify
	Bulleted list	Bulleted list
	Numbered list	Numbered list
	Decrease indent	Decrease indent
	Increase indent	Increase indent
	Clear formatting	Clear formatting

Maths toolbar

Each button types its symbol or template into the maths line you are editing, or starts a new maths line at the red cross. A | in a template marks where the cursor goes.

Button	Name	What it does
	$:=$	Define a variable (for a new name, a plain = also defines it)
	$=$	Calculate: show the value (or define a new name)
	$=$	Plain equals sign: shows = and calculates nothing (Ctrl+= while typing maths)
	$\leq$	Check: less than or equal (shows TRUE / FALSE)
	$\geq$	Check: greater than or equal
	$\neq$	Check: not equal

Button	Name	What it does
?:	?:	Choose: condition ? value if TRUE : value if FALSE
x^2	x^2	Square
x^n	x^n	Power
$\sqrt{}$	$\sqrt{}$	Square root
$\sqrt[n]{}$	$\sqrt[n]{}$	Nth root
$ x $	$ x $	Absolute value
$(\)$	$(\)$	Brackets
$\int$	$\int$	Definite integral
d/dx	d/dx	Derivative
Σ	Σ	Summation
$[\]$	$[\]$	Matrix: commas separate columns, semicolons separate rows
A^{-1}	A^{-1}	Inverse
$ A $	$ A $	Determinant
A^T	A^T	Transpose
$[A, B]$	$[A, B]$	Join side by side: $[A, B]$
$[A; B]$	$[A; B]$	Stack: $[A; B]$
$A_{i \ j}$	A_{ij}	Element: $A[\text{row}, \text{column}]$
α	α	Insert alpha
β	β	Insert beta
γ	γ	Insert gamma
δ	δ	Insert delta
ε	ε	Insert epsilon
θ	θ	Insert theta
λ	λ	Insert lambda
μ	μ	Insert mu
ν	ν	Insert nu
ρ	ρ	Insert rho
σ	σ	Insert sigma
τ	τ	Insert tau

Button	Name	What it does
	ϕ	Insert phi
	ω	Insert omega
	Δ	Insert Delta
	π	Insert pi

Spreadsheet toolbar

Name renames the selected spreadsheet (use it in maths as Name!B2); **Header row** makes the first row the column headings.

Button	Name	What it does
	 Editor	Open the spreadsheet editor: tabs, fill handle, sort, filter, functions (or double-click a cell)
	+ Row	Insert a row below the current cell
	- Row	Delete the current row
	+ Col	Insert a column to the right
	- Col	Delete the current column
	Wider	Make the selected columns wider
	Narrower	Make the selected columns narrower
	Copy ref	Copy a reference like T1!B2 to use this cell in maths
	Format ▼	All spreadsheet options: rows, columns, bold, alignment, fill and text colour, decimal places
	Import...	Fill the selected spreadsheet from a .xlsx workbook or a .csv file, or add a new spreadsheet if none is selected
	.xlsx...	Save the selected spreadsheet as a .xlsx workbook
	.CSV...	Save the selected spreadsheet as a .csv file

Drawing editor: Standard, Draw and Annotate

Button	Name	What it does
	Select	Back to selecting (Esc). Click objects, or drag a window: left to right takes objects fully inside, right to left anything it touches. Shift+click removes from the selection. Drag the blue grips to change a shape.
	Pan	Drag to move the view (P). The mouse wheel zooms around the pointer at any time.
	Zoom window	Zoom window (ZW): drag a box round the part you want to fill the screen.
	Zoom extents	Zoom extents (ZE): fit the whole drawing in the window.
	Undo	Undo the last change in the drawing (Ctrl+Z, U).
	Redo	Redo (Ctrl+Y).

Button	Name	What it does
	Line	Line (L): click a start point, then each next point. Type a length to go that far towards the pointer, @dx,dy for a relative point or @length<angle. Enter ends; C closes.
	Polyline	Polyline (PL): joined segments that stay one object. Enter ends, C closes it (a closed polyline can be hatched or extruded).
	Rectangle	Rectangle (REC): two opposite corners, or a corner then @width,height.
	Polygon	Polygon (POL): the number of sides, the centre, then a corner (inscribed) or the middle of a side (C for circumscribed).
	Circle	Circle (C): the centre, then the radius (click or type). 2P: two ends of a diameter; 3P: three points on the circle.
	Arc	Arc (A): three points on the arc; or C for centre, start and end (anticlockwise).
	Ellipse	Ellipse (EL): the centre, the end of one axis, then the length of the other half-axis.
	Spline	Spline (SPL): a smooth curve through the points you click. Enter ends, C closes.
	Point	Point (PO): a node mark that objects can snap to.
	Hatch	Hatch (H): opens the Hatch panel. Pick a pattern, scale, angle and colour, then click inside closed shapes to fill them; shapes inside are left open. "Use selected shapes" fills shapes you selected first.

Button	Name	What it does
	Text	Text (T): the insertion point, the height, the rotation, then type the text and press Enter.
	Linear dimension	Linear dimension (DLI): two points, then where the dimension line goes. H or V forces horizontal or vertical; type a number to place it that far away.
	Aligned dimension	Aligned dimension (DAL): measures the true distance between two points, parallel to them.
	Angular dimension	Angular dimension (DAN): pick two lines, then where the arc goes.
	Radius dimension	Radius dimension (DRA): pick a circle or arc, then where the leader goes.

Button	Name	What it does
	Diameter dimension	Diameter dimension (DDI): pick a circle or arc, then where the leader goes.
	Leader	Leader (LE): the arrow point, the bend, then the note text.

Drawing editor: Modify

Button	Name	What it does
	Move	Move (M): select objects (or use the selection), Enter, then a base point and the new position, or type a distance.
	Copy	Copy (CO): like Move, but the original stays. Keeps placing copies until Enter.
	Rotate	Rotate (RO): select, base point, then the angle (click or type degrees, anticlockwise positive).
	Scale	Scale (SC): select, base point, then the factor (type 2 for double size, 0.5 for half).
	Mirror	Mirror (MI): select, then two points on the mirror line; Y or N keeps or deletes the original.
	Offset	Offset (O): type the distance, pick the object, then click on the side to offset to. Repeats until Enter.
	Trim	Trim (TR): click the parts of lines to cut away where they cross other objects.
	Extend	Extend (EX): click the end of a line to lengthen it up to the next object it meets.
	Fillet	Fillet (F): R sets the radius, then pick two lines to join them with an arc (radius 0 makes a sharp corner).
	Chamfer	Chamfer (CHA): D sets the two distances, then pick two lines to cut the corner.
	Array	Array (AR): copies in rows and columns (type the counts and spacings) or around a centre (P for polar).
	Stretch	Stretch (S): drag a crossing window (right to left) round the points to move, Enter, then base point and new position.
	Break	Break (BR): pick an object at the first break point, then the second point; the part between is removed.
	Break at point	Break at point (BA): splits an object into two at one point.
	Join	Join (J): joins lines and polylines that touch end to end into one polyline.
	Explode	Explode (X): turns polylines, rectangles and polygons back into separate lines.
	Match properties	Match properties (MA): pick the source object, then the objects that should get its layer, colour and linetype.
	Erase	Erase (E or Delete): removes the selected objects.

Drawing editor: Inquiry, 3D solids, Drafting and Layers

Button	Name	What it does
	Distance	Distance (DI): two points; shows the distance, the angle and the change in X and Y in the command history.
	Area	Area (AA): click the corners of an area, or pick a closed object (O); shows area and perimeter.
	Point coordinates	Point coordinates (ID): click a point to see its X and Y.
	List	List (LI): shows the full data of the selected objects in the command history.

Button	Name	What it does
	Extrude	Extrude (EXT): turns closed shapes into solids of the height you type.
	Revolve	Revolve (REV): turns a closed shape round an axis (two points) by an angle.
	Box	Box (BOX): a corner, the opposite corner, then the height.
	Cylinder	Cylinder (CYL): centre, radius, height.
	Cone	Cone (CONE): centre, base radius, height.
	Sphere	Sphere (SPHERE): centre and radius.

Button	Name	What it does
	Snap to grid	Snap to grid (F9): the pointer jumps to the grid. Green when on.
	Object snap	Object snap (F3): the pointer catches end points, mid points, centres, intersections and so on (choose which in Properties). A green mark shows the snap.
	Ortho	Ortho (F8): lines and moves go only horizontally or vertically.

Button	Name	What it does
0 	Current layer	The current layer: new objects are drawn on it.
	Layer properties	Layer Properties (LA): the table of all layers, see the Drawings chapter.

Drawing board

Button	Name	What it does
	Pencil	Pencil (P)
	Brush	Brush (B): soft, pressure-sensitive with a pen
	Marker	Marker (M): see-through highlighter
	Eraser	Eraser (E)
	Line	Line (L): hold Shift for 0°, 45°, 90°
	Arrow	Arrow (A)
	Rectangle	Rectangle (R): hold Shift for a square
	Ellipse	Ellipse (O): hold Shift for a circle
	Fill	Fill (F): fills an area with the colour
	Text	Text (T): click where the text goes
	Colour picker	Colour picker (I): take a colour from the board

CHAPTER 4

Your first worksheet

This takes about two minutes. You will work out an average speed and show it in two different units.

- 1 Choose **File ► New worksheet**. Click near the top left of the empty sheet: a red cross appears. That is where your maths will go.
- 2 Type $d = 120 \text{ km}$ and press **Enter**. Because d is a new name, the $=$ defines it: the line is typeset as $d := 120 \text{ km}$ and the cursor moves below it. (Typing $:=$ does the same.)
- 3 Type $t = 1.5 \text{ h}$ and press **Enter**.
- 4 Type $v = d/t = \text{km/h}$ and press **Enter**. The answer appears: 80 km/h .
- 5 Type $v = \text{m/s}$ and press **Enter**. The same speed is shown as 22.22 m/s .
- 6 Double-click the first line and change 120 to 150. Press **Enter**. Both speeds update at once.

Placing and arranging regions

To...	Do this
Start a maths line	Click an empty spot on the sheet and type. Or Insert ► Maths .
Start a text block	Click an empty spot and type a double quote (") as the first key, or use Insert ► Text . Any other first key starts a maths line; a new line with a word, a space and another word (for example <i>Total load</i>) turns into text. Otherwise a maths line stays maths and a text block stays text.
Select a region	Click it once. Shift+click adds more; or drag a box around several on empty paper. Dragging never selects the letters inside regions, even next to a picture.
Edit a region	Double-click it, or select it and press Enter . Spreadsheet cells are clicked directly.
Move regions	Press anywhere on a region and drag it (or drag the dotted handle at its left). Arrow keys nudge selected regions. The region shows in its finished, typeset form while it moves or is resized.
Edit with the keyboard	Move the red cross onto a region with the arrow keys and press Enter : it opens for editing. Press Enter twice within 1.5 seconds and you leave it again and space is added, as on empty paper.
Delete regions	Select them and press Delete , or click the red $\times$ on the selected region. The gap closes.
Make space	Place the cursor and press Enter : everything below moves down. Backspace and Delete remove empty space above or below the cursor.
Put two items on one row	Place the second one to the right of the first. Items on the same row are calculated left to right.

Copying several regions at once

Select the regions (Shift+click each, or drag a box around them on empty paper), press **Ctrl+C**, click where they should go and press **Ctrl+V**. They paste exactly as they were: the same layout, sizes, formats, notes and pictures. This also works between two Equation Pad tabs or windows. Pasted into another program, they arrive as plain text.

ORDER MATTERS

Calculation runs from the top of the first sheet to the bottom of the last, and left to right along a row. A variable must be defined above (or to the left of) any line that uses it.

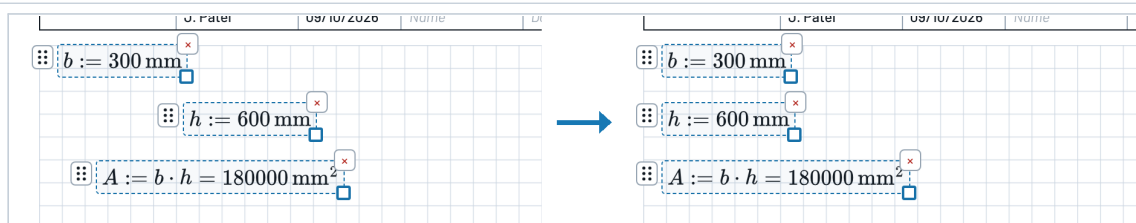
Aligning regions and centring them on the sheet

The **Arrange** toolbar (View ► Toolbars ► Arrange; also Format ► Arrange regions, and Arrange ► in the right-click menu) lines regions up:



The Arrange toolbar.

Button	What it does
Align left edges	The selected regions line up one under the other, on the left edge of the leftmost one. Overlaps are pushed apart.
Align tops	The selected regions line up side by side in one row, on the top of the highest one, left to right. If they do not fit across the sheet, some move below.
Left margin · Centre on the sheet · Right margin	Each selected region moves to the left margin, to the middle of the sheet or to the right margin. Works for one region or several.
Match properties	Copies size and format, see below.
Reset size to 100%	Returns resized maths lines and spreadsheets to their normal size.



Three maths lines selected (left), then Align left edges (right).

Match properties

- 1 Select the region whose look you want to copy (for example a maths line you made bigger).
- 2 Click **Match properties** (the brush) on the Arrange toolbar. The pointer changes.
- 3 Click each region that should match. Press Esc, or click empty paper, when you are done.
 - Maths line → maths line: the same size and the same result format.
 - Text → text: the same font, size, colour and width.
 - Between maths and text the size is matched, so text can be as big as the formulas next to it (and the other way round).
 - Spreadsheets get the same size; pictures, drawings and drawing boards the same width.
 - With several regions selected, Match properties copies from the first one you selected to all the others at once. Undo takes each step back.

CHAPTER 5

Sheets, title block, grid and footer

Every sheet looks like a finished calculation sheet: a title block with your logo and sign-off boxes at the top, a ruled grid in the working area and a footer line at the bottom.

Equation Pad	PROJECT Equation Pad examples				JOB NO. EP-001	SHEET 1 of 2
	CALCULATION FOR Feature tour					REVISION 0
	CALCULATED BY A. Author	DATE 07/10/2026	CHECKED BY B. Checker	DATE 08/10/2026	APPROVED BY C. Approver	DATE 09/10/2026

The title block: logo box, project details, revision and sign-off boxes with dates.

Filling in the title block

Click straight into any box of the title block and type. Press Enter when done. The same details appear on every sheet. You can also use **File ► Sheet header details**, which lists every box in one dialog.

Box	What to type
Project	The project name.
Job no.	Your job or project number.
Sheet	Filled in automatically, e.g. "2 of 5".
Calculation for	What this calculation is about. This also becomes the name shown in the title bar and the suggested file name.
Revision	The issue or revision, e.g. 0, A, P1.
Calculated by · Date	Who prepared the calculation, and when.
Checked by · Date	Who checked it, and when.
Approved by · Date	Who approved it, and when.

Empty boxes show a grey hint (for example "Name" or "Date") on screen only; the hints are never printed.

Adding your company logo

- 1 Click the box at the left of the title block that says **Click to add logo**.
- 2 Choose a JPEG or PNG file. PNG files with a transparent background work best.
- 3 The logo appears on every sheet. Click it again to replace or remove it.

The logo is stored inside the worksheet file, so it travels with it. Starting a new worksheet keeps the same logo. The width of the logo box is set in Page setup (0 mm removes the box).

File ► Sheet header details: every title-block box, plus the logo, in one place.

Page setup

File ► Page setup (or the page button on the Standard toolbar) controls:

- Paper size (A4, A3, A5, Letter, Legal) and orientation.
- Margins in millimetres.
- Whether the title block and the footer are shown, and the width of the logo box.
- The paper grid (see below).
- **Title block captions:** the small printed words above each box, such as “Job no.”. Change them only if you want different wording, for example “Project No.” or “Designed by”. The project details themselves go in the boxes on the sheet, not here.

Page setup, including the grid settings.

The paper grid

The working area of each sheet carries a thin box grid, like squared engineering paper. In Page setup you can set:

Setting	Choices
Show the grid	On or off (also View ► Grid).
Print and export the grid	On: the grid prints, and appears in PDFs and exported pages (it prints even when the browser's "background graphics" option is off). Off: it shows on screen only.
Style	Lines (box grid) or dots.
Spacing	1 to 50 mm; 5 mm is the default.
Thickness	0.1 to 4 pixels; thin lines (about 0.6) print lightly.
Colour	Any colour; a pale blue-grey is the default.

Designing the footer

The footer has three parts: left, centre and right. In **Page setup ► Footer** type whatever you like into each part, choose the text size and whether it is in capital letters. Words in curly brackets fill themselves in on every sheet:

Write	Shows
{project} {job} {title} {rev}	Project, job number, "Calculation for" and revision from the title block
{by} {checked} {approved}	The names from the sign-off boxes

Write	Shows
{date} {today}	The date in the title block, or today's date
{sheet} {sheets}	This sheet number, and the total number of sheets
{file}	The worksheet file name

For example, left {title} – rev {rev}, centre Page {sheet} of {sheets} and right Your Company Ltd. Leave a part empty to show nothing there; **Default footer** restores the original layout. Untick “Show the footer” to remove it altogether.

New sheets and page breaks

Sheets are added automatically as content grows; a region never splits across two sheets. To start a new sheet on purpose, use **Insert ► Page break**. Insert ► New sheet at end adds an empty sheet, and Remove empty last sheet takes it away again.

CHAPTER 6

Writing maths

A maths line is plain typing that turns into typeset maths when you press Enter. There are three kinds of equals sign: $:=$ defines, $=$ calculates (and also defines a name that is new), and $\equiv$ is a plain equals sign that calculates nothing.

You type	Meaning	Shows as
$d := 120 \text{ km}$	Define a variable	$d := 120 \text{ km}$
$d/t =$	Show a value	$d/t = 80 \text{ km/h}$
$d/t = \text{m/s}$	Show it in other units	$= 22.22 \text{ m/s}$
$v := d/t =$	Define and show on one line	$v := d/t = 80 \text{ km/h}$
$v := d/t = \text{m/s}$	Define, show and convert	$v := \dots = 22.22 \text{ m/s}$
$d*2$	An expression with no $=$ is shown, not evaluated	$d \cdot 2$
$d = 150 \text{ km}$	d already exists: $=$ redefines it from here on	$d := 150 \text{ km}$
$a \equiv b + c$	Plain equals (Ctrl+=): typeset only	$a = b + c$

Maths line or text line?

A new line is a maths line. It becomes a text line when you press “ first, or when it starts with a word, a space and another word with no operator, number or bracket, such as *Total load on the beam*. A line that starts with (always stays maths. Once a line is maths it stays maths, and a text line stays text.

Names with subscripts

An underscore starts the subscript: A_s shows as A_s . A dot inside the subscript is part of the name: $A_{s.req}$, $f_{c.k}$, $b_{eff.1}$. A second underscore separates parts of the subscript with a comma: $M_{Ed,y}$ shows as $M_{Ed,y}$.

Formatting maths lines

The Text formatting toolbar also works on maths lines. Select one or more maths lines, or edit one, and use bold, italic, underline, strikethrough, text colour, highlight, bigger / smaller or a size (11 pt is 100%). Ctrl+B and Ctrl+I work on a selected maths line. Clear formatting takes it all off. Paragraph styles, lists and alignment apply to text only.

$$F_{Ed} := 1.35 \cdot 25 \text{ kN} + 1.5 \cdot 12 \text{ kN} = 51.75 \text{ kN}$$

$$M_{Ed} := \frac{F_{Ed} \cdot 6 \text{ m}}{4} = 77.63 \text{ kN} \cdot \text{m}$$

$$A_{s.req} := 452 \text{ mm}^2$$

A bold red line and a highlighted line.

The three equals signs

Sign	How to type it	What it does
<code>:=</code>	Type <code>:=</code> or the <code>:=</code> button	Always defines (or redefines) the name on its left.
<code>=</code>	Type <code>=</code>	After a name that is not defined yet, it defines it, exactly like <code>:=</code> . At the end of a line it calculates and shows the value. After an existing name followed by a unit, it converts: $v = \text{km/h}$.
<code>□</code>	Ctrl+= while typing maths, or the <code>□</code> button	A plain equals sign with no meaning for the calculation, for writing out a derivation or a formula: $F \propto m \cdot a$. Nothing on the line is calculated, so it never shows an error.

Operators and shortcuts

Write	For	Also accepted
<code>+ - * /</code>	Add, subtract, multiply, divide	<code>· × ·</code> for multiply; <code>÷</code> for divide; <code>\cdot</code>
<code>^</code>	Power: x^2 , $x^{(1/3)}$	<code>² ³ ⁴</code> directly after a name
<code>sqrt(x)</code>	Square root	$\sqrt{x}$
<code>nthRoot(x, 3)</code>	Cube (or nth) root	
<code>()</code>	Group terms	
<code><= >= < > == !=</code>	Comparisons, giving TRUE or FALSE	<code>≤ ≥ ≠</code>
<code>and or not</code>	Combine comparisons	
<code>c ? a : b</code>	If c is TRUE then a, otherwise b	
<code>2e-3</code>	Scientific notation (0.002)	
<code>pi e g</code>	The constants π , e and standard gravity $g = 9.80665 \text{ m/s}^2$	π

Decimal places, text and gravity

You type	Shows
<code>F = ?4 kN</code>	F in kN with exactly 4 decimal places: 12.3457 kN.
<code>F = ?0</code>	F rounded to a whole number, in its own unit: 12 kN.
<code>W := m*g = ?2 kN</code>	Defines W and shows it in kN with 2 decimal places.
<code>("I have taken " + x + " apples.") =</code>	Text joined with values: I have taken 25 apples.
<code>("Span = " + L) =</code>	A value with its unit inside text: Span = 2.5 m.
<code>msg := "Span = " + L</code>	Keeps the text in a variable; <code>msg =</code> shows it.
<code>W := m*g</code>	g is standard gravity, 9.80665 m/s^2 . Define <code>g := 9.81 m/s^2</code> to use your own value; straight after a number, g is the gram (5 g).

Start such a line with a bracket or a name, not with `:`: a `"` as the very first key starts a text block. Inside a maths line a `"` is always part of the maths, and the line stays a maths line.

`?n` always shows exactly n digits after the decimal point, so `?3` gives 2.500, not 2.5. Without `?n` the result format of the worksheet is used (chapter “Result format and calculation”).

$$\begin{aligned}
 F &:= 12.3456789 \text{ kN} \\
 F &= 12.3457 \text{ kN} \\
 F &= 12 \text{ kN} \\
 m &:= 1200 \text{ kg} \\
 W &:= m \cdot g = 11.77 \text{ kN} \\
 x &:= 25 \\
 &\text{I have taken 25 apples.} \\
 a &:= 3 \\
 a \leq 5 &= \text{TRUE}
 \end{aligned}$$

Exactly 4 and 0 decimals, standard gravity, text joined with a value, and a check.

How lines are displayed

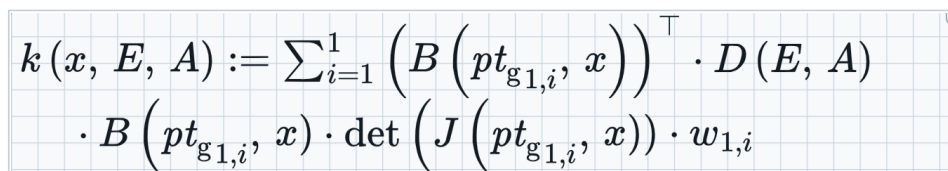
- Divisions become fractions. Brackets you typed around a numerator or denominator are dropped, because the fraction bar already groups them.
- A minus sign in front of a fraction stays outside it: $-1/3$ shows as $-\frac{1}{3}$ (minus one third), not as a fraction with -1 on top. The same holds for $-2*a/b$.
- Brackets around a power are dropped: $x^{(1/3)}$ shows the fraction raised as an exponent.
- An underscore makes a subscript: x_1 , v_{max} , $T_{\text{in_out}}$ (several parts are separated by commas).
- Greek names become Greek letters: alpha, beta, Delta, omega; epsilon gives ϵ and phi gives ϕ , as on the Maths toolbar (varepsilon and varphi give ϵ and ϕ). You can also type the letters directly. They stay sharp at every size.
- Known units are set upright (km, h, m/s) and variables in italics. A number and its unit stay together as one quantity: 9.81 m/s^2 and 3 kN/m^2 are written the way you would on paper, never as a fraction of a number.
- Numbers keep the digits you typed: 25.0 km/h shows 25.0, not 25.
- Curly brackets group without showing brackets, as in LaTeX: $\{a + b\}/c$ puts $a + b$ over c with no brackets drawn, and x^{n+1} raises the whole of $n + 1$. Use them whenever you want to keep a part together.

$$\begin{aligned}
 l &:= 25.0 \text{ km/h} = 6.944 \text{ m/s} \\
 g &:= 9.81 \text{ m/s}^2 \\
 q &:= 3 \text{ kN/m}^2
 \end{aligned}$$

Quantities with units, a conversion on the same line, and typed digits kept (25.0).

Long lines

A line that is too wide for the sheet wraps onto the next line between its terms (at + and −), between the factors of a product (at ×, and before a fraction), and before the = of the result. Long lines also wrap **inside** summation, integrals, derivatives, long brackets and long function calls, so a stiffness matrix such as $k(x, E, A) := \text{summation}(\text{transpose}(B(\dots)) \cdot D(E, A) \cdot B(\dots) \cdot \det(J(\dots)) \cdot w[1, i], i, 1, n)$ wraps between its factors. A number and its unit, such as 1000 kN·m, and short functions such as B(x, y) always stay together. The continuation is indented. Very wide single items such as a big matrix do not wrap; make them smaller instead.



$$k(x, E, A) := \sum_{i=1}^1 \left(B \left(pt_{g1,i}, x \right) \right)^T \cdot D(E, A) \\ \cdot B \left(pt_{g1,i}, x \right) \cdot \det \left(J \left(pt_{g1,i}, x \right) \right) \cdot w_{1,i}$$

A long summation wraps between its factors when the line is too wide for the sheet.

Suggestions while you type

As you type, a list shows matching variables, functions and units. Use ↑ and ↓ to choose and **Tab** to insert. Clicking a name in the variable store inserts it too.

Errors

A line with a problem is underlined in red and the message appears beneath it. The status bar counts errors; click the count to jump to the first one. Chapter 20 lists the common messages and their fixes.

CHAPTER 7

Units

Units are part of every value. Equation Pad checks them, cancels them and converts them for you, so you never multiply by conversion factors yourself.

Built-in units

Several hundred units are built in, in the SI system with all the usual prefixes and in imperial and US customary units. A few examples:

Quantity	Examples
Length	mm, cm, m, km, um (micrometre), inch, ft, yd, mi, nmi
Area, volume	mm ² , m ² , ha, acre, sqft · mL, L, m ³ , gal, impgal, cft
Mass	g, kg, t (tonne), lb (lbm), oz, slug
Time, frequency	s, ms, min, h, day · Hz, kHz, rpm
Speed, acceleration	m/s, km/h (kph), mph, knot, fps · m/s ² , g0 style constants can be defined
Force, pressure	N, kN, MN, lbf, kip, kgf · Pa, kPa, MPa, GPa, bar, atm, psi, ksi
Energy, power	J, kJ, MJ, kWh, cal, kcal, BTU · W, kW, MW, hp
Electrical	A, mA, V, kV, ohm, W, VA, kVA, C, F, H
Temperature, angle	K, degC, degF · rad, deg, rev, gon
Flow, density	m ³ /s, L/s, lpm, gpm, cfs · kg/m ³ , g/cm ³ (gcc), lb/ft ³

Every SI prefix works with every SI unit: q, r, y, z, a, f, p, n, μ (type u, μ or μ), m, c, d, da, h, k, M, G, T, P, E, Z, Y, R and Q, as in mm, μ m, kN, MN, GPa, kWh, MBq or mGy. Ω can be typed for ohm (4.7 k Ω). Units without a usual symbol are built in as well: Nm (with kNm, MNm...), lm, lx, Bq, Gy, Sv, kat and kcal.

Insert ► Unit (Ctrl+U) lists every unit by quantity, with a search box. Inches are written **inch**, because **in** is a reserved word.

Insert unit

My units (0)

All quantities

Unit	Quantity	Equals (SI)	Also written as
m *	Length	1 m	meter, meters
ch	Length	20.1168 m	chain, chains
cm	Length	0.01 m	
ft	Length	0.3048 m	feet, foot
in	Length	0.0254 m	inch, inches
km	Length	1000 m	
li	Length	0.201168 m	link, links
mi	Length	1609.34 m	mile, miles
mm	Length	0.001 m	
nm	Length	1e-9 m	
rd	Length	5.02921 m	
um	Length	1e-6 m	
yd	Length	0.9144 m	yard, yards

225 units. Units marked with * accept SI prefixes (k, M, G, m, c, μ written as u...). Inches are written inch, because in is reserved. Click a unit to insert it.

Close

The unit list, with your own units at the top.

Converting

Write the unit you want after the =: $v = \text{km/h}$, $E = \text{kWh}$, $A = \text{mm}^2$. If the units are not compatible you get the message “Units do not match”.

Results without a requested unit use a sensible unit: a value you typed with one unit keeps it, and combined units are shown in the unit system chosen in Format ► Result format (SI, engineering SI or US customary).

Your own units

- 1 Open **Insert ► Unit** and expand **My units** (or Help ► Add my own unit).
- 2 Give the unit a name, for example `crate`, and say what it equals, for example `12.5 kg`.
- 3 Tick “Allow prefixes” if you want k, M, m and so on to work with it. Click **Add unit**.

Your units are saved in the worksheet file and work exactly like built-in ones: `n := 4 crate` then `n = kg` shows 50 kg.

When a variable has the same name as a unit

Variables and units are kept apart. **A unit written straight after a number is always the unit**, even when a variable has the same name: after `m := 5 kg`, the line `F := m*9.81 m/s^2` multiplies the variable `m` by 9.81 metres per second squared, and `L := 3 m` is three metres. Units that continue such a quantity with * or / count too, as in `2 kN*m` and `5 kN/m^2`.

Everywhere else a defined name is the variable: `m^2` is twice the mass. On the sheet you can always tell them apart: units are upright (`m`), variables are italic (*m*). If you mean a variable straight after a quantity, write it first: `w := s_j*2.2 kPa` rather than `2.2 kPa*s` (which would mean seconds). Names to watch: m, s, g, h, t, N, V, A, S, T, F, J, W, L.

$$F := \frac{m \cdot 9.81 \text{ m}}{\text{s}^2} = 49.05 \text{ N}$$

$$L := 3 \text{ m} = 3 \text{ m}$$

m is a variable (italic); the m and s after 9.81 are units (upright).

Two units also exist as functions: min and sec. Written without brackets they are the units minute and second (0.08 /min, 30 sec); with brackets they are the functions (min(3, 4), sec(x)).

TEMPERATURES

Temperatures with an offset (degC, degF) convert correctly as single values, but differences and products of temperatures should be written in K to avoid surprises.

CHAPTER 8

Functions, calculus and logic

Your own functions

```
f(x) := 3*x^2 - 2*x + 1
f(2) =                               → 9
area(w, h) := w*h
area(3 m, 2 m) =                     → 6 m²
```

Parameters are plain names. A function may use any variable defined above it. Functions can call other functions, but a function must never call itself, directly or through another function (see “Endless loop” in chapter 20).

Calculus

Write	Result
<code>integrate(f(x), x, 0, 2) =</code>	Definite integral of f from 0 to 2 (here 6). Limits with units must use the same units, e.g. 0 m and 3 m.
<code>diff(f(x), x, 2) =</code>	Derivative of f at x = 2 (here 10).
<code>diff(f(x), x)</code>	The derivative itself, shown as an expression.
<code>summation(k^2, k, 1, 10) =</code>	Sum of k ² for k = 1 ... 10 (here 385).

Integrals use a high-order numerical method and are accurate for smooth functions. Derivatives are worked out exactly when possible and numerically otherwise.

Checks: TRUE and FALSE

A comparison shows a green **TRUE** or red **FALSE** tag: `total <= budget =`. Combine conditions with `and`, `or` and `not`: `x > 0 and x < 10 =`. A condition can choose between two values: `rate := (n > 100) ? 0.9 : 1.0`.

Built-in functions

The most used functions are listed below; Appendix A has the full list.

Group	Functions
Rounding, sign	<code>abs</code> , <code>round(x, n)</code> , <code>floor</code> , <code>ceil</code> , <code>fix</code> , <code>sign</code> , <code>mod(a, b)</code>
Powers, logs	<code>sqrt</code> , <code>nthRoot(x, n)</code> , <code>exp</code> , <code>log (natural)</code> , <code>log10</code> , <code>log2</code> , <code>pow</code>
Trigonometry	<code>sin</code> , <code>cos</code> , <code>tan</code> , <code>asin</code> , <code>acos</code> , <code>atan</code> , <code>atan2(y, x)</code> , <code>sinh</code> , <code>cosh</code> , <code>tanh</code> ; angles in rad by default, or write 30 deg
Statistics	<code>min</code> , <code>max</code> , <code>sum</code> , <code>mean</code> , <code>median</code> , <code>std</code> , <code>variance</code> , <code>prod</code>
Tables of values	<code>interp(x, X, Y)</code> : straight-line interpolation in a list of points
Matrices	see chapter 8

CHAPTER 9

Matrices

Matrices are written row by row: commas separate the columns and semicolons separate the rows.

$A := [4, -2; 1, 1]$	a 2×2 matrix
$b := [2; 3]$	a column (2×1)
$r := [1, 2, 3]$	a list of three values, shown as a column

3. Matrices

Commas separate columns and semicolons separate rows. **[A, b]** joins side by side; **[A; B]** stacks.

$$A := \begin{bmatrix} 4 & -2 \\ 1 & 1 \end{bmatrix}$$

$$b := \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

$$x := \text{lusolve}(A, b) = \begin{bmatrix} 1.333 \\ 1.667 \end{bmatrix}$$

$$\det(A) = 6$$

$$C := [A \ b] = \begin{bmatrix} 4 & -2 & 2 \\ 1 & 1 & 3 \end{bmatrix}$$

$$\begin{bmatrix} A \\ [0 \ 1] \end{bmatrix} = \begin{bmatrix} 4 & -2 \\ 1 & 1 \\ 0 & 1 \end{bmatrix}$$

Solving a system, a determinant, and joining matrices into blocks.

Typing a matrix of any size

The matrix button (Maths or Insert toolbar, or Insert ► Maths ► Matrix) opens a grid of boxes between big brackets next to the line, so you type the matrix the way it looks. **Tab** goes to the next box and adds a row after the last one, **Enter** goes to the box below, a **comma** adds a column and a **semicolon** a row; **+ Row**, **+ Column**, **– Row** and **– Column** do the same with the mouse. **Ctrl+Enter** or **Insert** puts the matrix into the line, written as $[12, -6; -6, 4]$; Esc cancels. With the caret inside a matrix that is already in a line, the same button opens that matrix in the grid and puts it back in its place. You can also simply type a matrix with commas and semicolons. Functions such as `zeros(18, 18)`, `ones(3, 4)` and `identity(6)` make large matrices directly.

Typing a 2×2 matrix in the grid.

Working with matrices

Write	Meaning
$A*b$	Matrix product
$A + B, 2*A$	Element sums and scaling
$A .* B$	Element-by-element product
$\text{inv}(A), \text{det}(A)$	Inverse, determinant
$\text{transpose}(A), A'$	Transpose
$\text{lusolve}(A, b)$	Solve $A \cdot x = b$ (faster and more accurate than $\text{inv}(A)*b$)
$A[2, 1]$	One element: row 2, column 1 (counting from 1)
$A[:, 1], A[2, :]$	A whole column, a whole row
$A[1:3, 2:4]$	A block of rows 1-3 and columns 2-4
$\text{size}(A)$	Number of rows and columns
$\text{eigs}(A)$	Eigenvalues and eigenvectors
$\text{trace}, \text{norm}, \text{dot}, \text{cross}, \text{diag}, \text{kron}$	Further matrix functions

Joining matrices (block matrices)

Inside square brackets you can place whole matrices, not only numbers:

Write	Result
$[A, b]$	A and b side by side. They need the same number of rows.
$[A; B]$	A on top of B. They need the same number of columns.
$[A, B; C, D]$	A 2×2 arrangement of blocks.
$[A; [0, 1]]$	A with an extra row added underneath.
$\text{concat}(A, B, 1)$	Stack (same as $[A; B]$).
$\text{concat}(A, B, 2)$	Side by side (same as $[A, B]$).

A plain list such as $[1, 2, 3]$ counts as a column when it is used as a block. Write a row as $[[1, 2, 3]]$ or give it its own row with a semicolon, as in $[A; [0, 1]]$.

Seeing large matrices

Matrices are shown in full up to 30 rows and 20 columns. A bigger result shows its size instead, for example “40×40 matrix”. Change the limits in **Format ► Result format** (up to 200 × 200), or look at part of the matrix with an index range such as $K[1:6, 1:6] =$. A wide matrix that does not fit the sheet can be scrolled sideways on screen.

Result format and units

Unit system for results

Engineering SI (kN, m, mm, MPa)

Number format

Significant figures

Significant figures

4

Decimal places

2

☒ Calculate automatically as I work

MATRICES

Show in full up to (rows)

30

and up to (columns)

20

A bigger matrix shows only its size, e.g. "40×40 matrix". To look inside one, show a part of it:
K[1:6, 1:6] =.

A result typed with a single unit (for example $L := 6\text{ m}$) keeps that unit. Combined units are shown in the system above. Write a unit after = to override one line, e.g. $P = \text{kW}$.

Cancel

Apply

Format ► Result format: number format, unit system and the matrix display limits.

Making a maths line or spreadsheet bigger or smaller

Like a picture, a selected maths line or spreadsheet has a blue square at its bottom-right corner. Drag it left to make the whole region smaller, or right to make it bigger (30% to 300%). This is the quickest way to fit a large matrix or a wide spreadsheet onto the sheet. Double-click the square, or use Format ► Regions ► Reset size, to go back to 100%. The size is saved with the worksheet and used when printing.

CHAPTER 10

Solving, symbolic maths and differential equations

Equation Pad can find where a function is zero, solve one equation or a system of equations, tidy up formulas symbolically and step a differential equation through time. Every one of these works with units.

$$f(x) := x^3 - 6 \cdot x^2 + 9 \cdot x + 1$$

$$\text{root}(f(x), x, -1, 0) = -0.1038$$

$$\text{solve}(\cos(x) = x, x, 0.5) = 0.7391$$

$$\text{sol} := \text{solve}\left(\begin{bmatrix} 2 \cdot x + y = 5 \\ x - y = 1 \end{bmatrix}, \begin{bmatrix} x \\ y \end{bmatrix}, \begin{bmatrix} 0 \\ 0 \end{bmatrix}\right) = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

$$\frac{d}{dx} f(x) = 3 \cdot x^2 + 9 - 12 \cdot x$$

A root in a range, an equation, a system of two equations and an exact derivative.

Roots and equations

Write	Result
$\text{root}(f(x), x, -1, 0) =$	The x between -1 and 0 where $f(x) = 0$. f must change sign between the two ends. This is the safest form.
$\text{root}(f(x), x, 2) =$	A root found by starting from the guess 2. If it fails, give a range instead.
$\text{solve}(\cos(x) == x, x, 0.5) =$	Solves an equation written with $==$ (shown as $=$). The guess or range works as for root.
$\text{solve}([2 \cdot x + y == 5, x - y == 1], [x, y], [0, 0]) =$	A system: a list of equations, a list of unknowns and one starting guess for each. The answer is a column of values in the same order (here 2 and 1).
$L := \text{root}(F(L) - 50 \text{ kN}, L, 1 \text{ m}, 10 \text{ m}) =$	Units work as usual: the answer has the units of the guess or range.

WHICH ROOT?

A non-linear equation can have several roots. The one you get is the one nearest your guess, or the one inside your range. Plot the function first (chapter 10) to see where the roots are.

Symbolic maths

Write	Result
$\text{diff}(f(x), x) =$	The derivative as a formula (for $f(x) = x^3 - 6x^2 + 9x + 1$: $3x^2 + 9 - 12x$).
$\text{simplify}(2 \cdot x + 3 \cdot x - x^2/x) =$	A tidier form of the formula: $4x$.
$\text{expand}((x + 1)^2) =$	Brackets multiplied out: $x^2 + 2x + 1$.
$\text{simplify}(f(x) - g(x)) =$	Your own functions are written out first, then simplified.

Differential equations

ode(rate, t, y, t0, y0, t1, steps) steps the equation $dy/dt = \text{rate}$ from t_0 to t_1 with the fourth-order Runge-Kutta method. The answer is a table (matrix) with time in the first column and y in the second. Steps is optional; the default is 100.

$k := 0.08 \text{ min}^{-1}$
$T_a := 20$
$\text{sol} := \text{ode}(-k \cdot (T - T_a), t, T, 0 \text{ min}, 90, 60 \text{ min}, 120)$
$\text{sol}_{61,2} = 26.35$

Cooling from 90 to 20 degrees: the value after 30 minutes is in row 61 (0.5 minute steps).

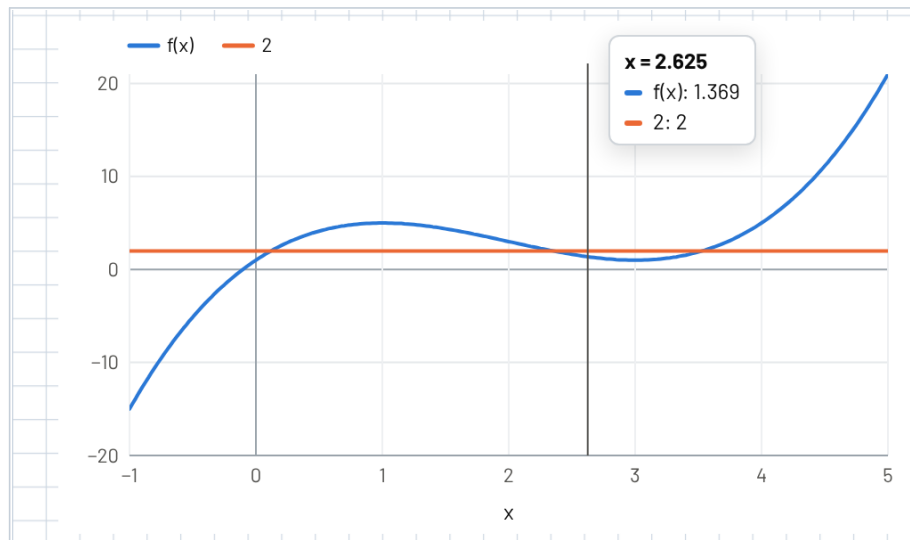
```
k := 0.08 /min
T_a := 20
sol := ode(-k*(T - T_a), t, T, 0 min, 90, 60 min, 120)
sol[61, 2] =                → 26.35
plot(sol[:, 1], sol[:, 2])  draws the curve
```

For a system, y is a list and the rate is a list of the same length, using $y[1]$, $y[2]$ and so on: with $w := 2$, $r := \text{ode}([y[2]; -w^2*y[1]], t, y, 0, [1; 0], 10, 200)$ returns the columns t , $y[1]$ and $y[2]$. The names used for time and for y (here t , y and T) are temporary inside `ode`, so they do not need to be defined beforehand.

CHAPTER 11

Graphs

A graph is a maths line that starts with plot. It is redrawn every time the worksheet calculates, so it always matches the numbers above it.



`plot([f(x), 2], x, -1, 5)`: two curves, a legend, and the read-out that follows the mouse.

Write	Draws
<code>plot(f(x), x, 0, 10)</code>	f against x from 0 to 10.
<code>plot([f(x), g(x), 2], x, 0, 10)</code>	Several curves on the same axes, with a legend. A plain number draws a level line.
<code>plot(M, x, 0 m, 6 m)</code>	Ranges with units: the axes are labelled with the units.
<code>plot(X, Y)</code>	Points joined by lines, from two lists of the same length (for example two spreadsheet columns or ode results).
<code>plot(X, Y, "points")</code>	The same values as separate markers.

- Point at a graph to read the values under the mouse; the read-out does not print.
- Insert ► Graph puts a template `plot( , x, 0, 10)` at the cursor.
- Select a graph and drag its blue corner square to make it bigger or smaller, like a picture.
- Graphs use clear, colour-blind-friendly colours and print and export to PDF exactly as on screen.

Graph types and settings

Double-click a graph (or right-click it ► Graph settings...) to change how it looks. The preview on the left follows every change; **Apply** keeps it.

Graph settings

Formula

```
plot([sin(x), cos(x), x/3], x, 0, 6)
```

GRAPH TYPE

Line

Line + points

Points(scatter)

Bars

Area

Steps

Polar $r(\theta)$

Parametric $x(t), y(t)$

SHOW

☒ Axes
 ☒ Grid
 ☒ Scale numbers
 ☐ Values at points
 ☒ Legend

SCALE

x from

auto

x to

auto

☐ Log x

y from

auto

y to

auto

☐ Log y

TITLES

Title

none

x axis

automatic

y axis

automatic

Width(px)

480

LINES

sin(x)

Solid

2

No marker

☐ Fill

cos(x)

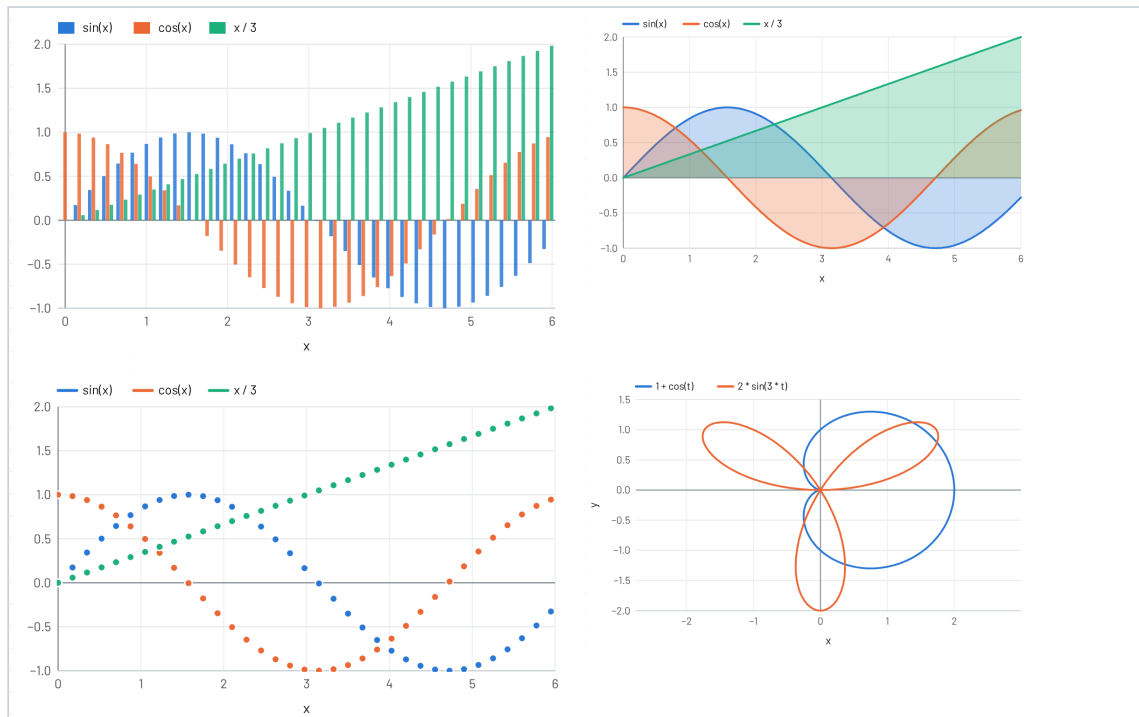
Reset

Cancel

Apply

The Graph settings window.

Setting	Choices
Graph type	Line · Line + points · Points (scatter) · Bars · Area · Steps · Polar $r(\theta)$ · Parametric $x(t), y(t)$.
Show	Axes, grid, scale numbers on the axes, values at the points, legend: tick or untick each.
Scale	x and y from / to (empty = automatic) and a logarithmic x or y axis.
Titles	A title for the graph and for each axis, and the width of the graph.
Each line	Colour, line style (solid, dashed, dotted, dash-dot or none), width, marker (circle, square, triangle...), fill under the line on or off, and how solid the fill is.



The same three functions as bars, area and points, and a polar graph.

- Several functions in one graph: `plot([sin(x), cos(x), x/3], x, 0, 6)`. Each gets its own line settings.
- Polar: `plot(1 + cos(t), t, 0, 2*pi)` with the type Polar $r(\theta)$. Parametric: `plot([cos(t), sin(2*t)], t, 0, 2*pi)` with the type Parametric.
- Data from two lists or spreadsheet columns: `plot(X, [Y1, Y2])` draws two series against X.
- The settings are saved with the worksheet and used in print, PDF and .docx.

CHAPTER 12

Programming

A program block holds a calculation that needs decisions or repetition: if, else, loops and return. Type it in the classic Equation Pad way (if ... end) or the Python way (def, indentation, range). On the sheet both are shown as a neat block with a bar marking each level, and both use units like the rest of the sheet.

```

grade(m) :=
  if m ≥ 70
    | return 1
  else if m ≥ 60
    | return 2
  else
    | return 3

grade(72) = 1

f(n) :=
  s ← 0
  for i ∈ 1, ..., n
    | s ← s + i2
  return s

f(10) = 385

```

Two program blocks on a sheet: a function with if / else if / else, and a sum built in a loop.

Making a program block

- 1 Choose **Insert ► Program block**. An example appears, already open for typing.
- 2 The first line names the result: a function such as `grade(m) :=` or `def grade(m) :`, or a value such as `total :=`.
- 3 Write one statement per line. Tab indents.
- 4 Press **Ctrl+Enter** or click outside to finish, **Esc** to cancel. Double-click the block (or right-click ► Edit) to change it later.
- 5 Use the result below the block like any function or variable: `grade(55) =`.

```

grade(m) :=
if m ≥ 70
    return 1
else if m ≥ 60
    return 2
else
    return 3
end

```

A program while it is being edited: plain typing, one statement per line.

The classic way

Line	Meaning
<code>s = 0</code> or <code>s := 0</code>	Give a local name a value (shown as $s \leftarrow 0$). Local names exist only inside the program.
<code>if m >= 70 ... else if ... else ...</code> <code>end</code>	Choose one branch. Every if needs its end.
<code>for i = 1 to n ... end</code>	Repeat for $i = 1, 2, \dots n$. Add step 2 (or -1 to count down).
<code>for v in [2, 5, 9] ... end</code>	Repeat for each value of a list, a matrix or a spreadsheet column.
<code>while err > 1e-6 ... end</code>	Repeat while the condition is TRUE.
<code>break / continue</code>	Leave the loop / go straight to its next round.
<code>return s</code>	Finish and give s as the answer. Without return, the last value calculated is the answer.
<code>// a comment</code> or <code># a comment</code>	Ignored, for your own notes.

```
f(n) :=
  s = 0
  for i = 1 to n
    s = s + i^2
  end
  return s
```

The Python way

If a program starts with `def`, or uses lines that end with a colon such as `if x > 0:`, it is read as Python. Blocks are marked by indentation, exactly as in Python; there is no end.

```
def f(n):
    s = 0
    for i in range(1, n + 1):
        s += i**2
    return s
```

```
def M_max(ws, L):
    m = 0 kN*m
    for w in ws:
        if w > 20 kN/m:
            continue
        m = max(m, w*L**2/8)
    return m
```

A program written the Python way, while it is being edited.

```


$$w_{\text{list}} := \frac{\begin{bmatrix} 8 \\ 12 \\ 15 \end{bmatrix} \text{ kN}}{\text{m}}$$


$$L := 6 \text{ m}$$


$$M_{\text{max}}(ws, L) :=$$


$$\quad m \leftarrow 0 \text{ kN}\cdot\text{m}$$


$$\quad \text{for } w \in ws$$


$$\quad \quad \text{if } w > 20 \text{ kN/m}$$


$$\quad \quad \quad \text{continue}$$


$$\quad \quad m \leftarrow \max\left(m, \frac{w \cdot L^2}{8}\right)$$


$$\quad \text{return } m$$


$$M_{\text{max}}(w_{\text{list}}, L) = 67.5 \text{ kN}\cdot\text{m}$$


```

The same program on the sheet: shown as a block, with units, and used in the line below it.

Python	Meaning in Equation Pad
<code>def name(a, b):</code>	The first line: a function with parameters a and b.
<code>if ...: elif ...: else:</code>	Branches, by indentation.
<code>for i in range(n):</code>	$i = 0, 1, \dots, n-1$. <code>range(a, b)</code> runs from a to b-1, <code>range(a, b, step)</code> with a step (negative steps count down).
<code>for v in values:</code>	Each value of a list, matrix or spreadsheet column.
<code>while ...: break continue return pass</code>	As in Python.
<code>x += 1 -= *= /=</code>	Short forms of $x = x + 1$ and so on.
<code>** // %</code>	Power, whole-number division (floor), remainder.
<code>True False and or not</code>	Logic.
<code>abs() min() max() len() math.sqrt() math.pi</code>	Built-in functions; math. may be left out. Every Equation Pad function can be used too.
<code># comment print(...)</code>	Comments are ignored; print lines are skipped (show results on the sheet instead).

PYTHON, THE CALCULATION PART

Equation Pad is not a full Python interpreter: there are no imports, classes, strings or lists that change size. What it offers is the Python way of writing numerical procedures, running on the same engine as the rest of the sheet, with units.

Examples

Choosing a value, such as a factor that depends on a slenderness:

```
def k_fac(lam):
    if lam <= 0.2:
        return 1
    elif lam <= 1.5:
        return 1.1 - 0.5*lam
    else:
        return 0.35
```

An iteration, Newton's method for a square root, stopped when the change is small:

```
def root2(x):
    y = x
    while abs(y*y - x) > 1e-9*x:
        y = (y + x/y)/2
    return y
```

Checking several load cases with units. The loads are a list defined above the block; the program returns the largest bending moment:

```
w_list := [8, 12, 15] kN/m
L := 6 m
def M_max(ws, L):
    m = 0 kN*m
    for w in ws:
        m = max(m, w*L**2/8)
    return m
M_max(w_list, L) = kN*m
```

Working through a spreadsheet: `for v in Loads[:, 2]:` visits each value of column 2 of the spreadsheet named Loads.

Rules and limits

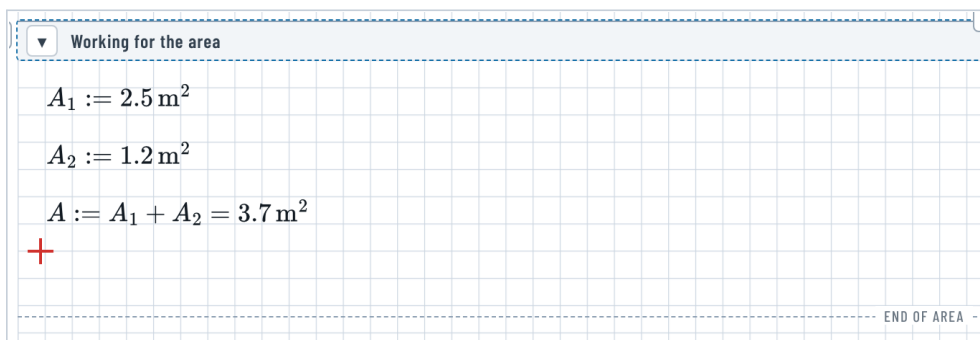
- A program can use every variable and function defined above it, units included. Names given a value inside the program are local: they do not change the sheet.
- A function program (`def f(...)` or `f(...) :=`) is defined, like `f(x) := ...`, and is called below it. A value program (`total :=`) is calculated where it stands.
- A program that is still running after 2 million steps is stopped with a message, so an endless loop can never freeze the app.
- Errors name the line of the program, for example "Line 4: a block is missing its end" or "Line 3: Undefined symbol k".

CHAPTER 13

Organising and presenting a worksheet

Long calculations stay readable when supporting work can be folded away, private reminders stay off the printout, and results can be revealed one step at a time.

Collapsible areas



An open area: a title bar, the content, and the end line.



The same area closed. Its three lines are hidden but still calculated.

- **Insert ► Collapsible area** places a title bar and an end line at the cursor. Click the title to rename it; press Enter when done.
- Put any regions between the two lines. Moving the end line down makes the area bigger; the area also grows as you add lines.
- Click ▼ at the left of the title bar (or select the area and press Enter) to close it, and ► to open it again.
- A closed area still calculates: variables defined inside it can be used below it. The bar tells you how many items are hidden.
- A closed area prints closed, showing only its title bar, so supporting working can be left out of a printed report.

Find and replace

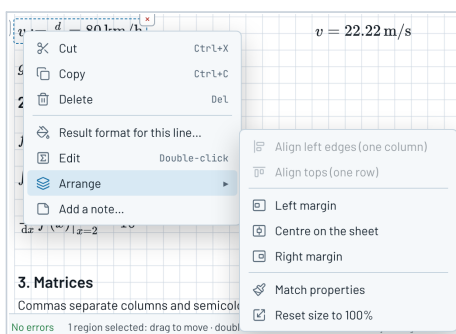
Ctrl+F (Edit ► Find) opens the find bar: type a word and press Enter to jump from one match to the next. Tick **Match case** to tell capitals from small letters. **Ctrl+H** (Edit ► Replace, or **Replace...** on the bar) adds a second box: type the new text, then **Replace** changes the highlighted region and moves on, and **Replace all** changes the whole worksheet. Maths lines, text, spreadsheet cells, programs and area titles are searched. Every replacement can be undone with Ctrl+Z.



Find and replace: renaming budget to limit everywhere.

Notes

Right-click any region and choose **Add a note...** to attach a private reminder, such as “check with the supplier”. A small yellow note mark appears beside the region; point at it to read the note, click it to edit. Notes are saved in the worksheet file but never printed or exported to PDF.



Right-click a region for its commands, including Add a note.

A result format for one line

Normally every result uses the setting in Format ► Result format. To show one line differently, for example a final answer to 2 decimal places, right-click it and choose **Result format for this line...**, tick “Use a format of its own”, and choose significant figures or decimal places. To show that one result in other units, simply write the unit after the =.

Result format for this line

☐ Use a format of its own (otherwise the worksheet setting is used)

Number format

Significant figures

Decimal places

Significant figures

4

2

To show this result in other units, write the unit after the = sign, for example $v = \text{km/h}$.

Cancel

Apply

The result format for a single line.

Step-by-step presentation

View ► Step-by-step presentation hides the worksheet and reveals it one region at a time, from the top, which is useful in meetings, reviews and lectures. The current region is highlighted and scrolled into view.



The presentation bar at the bottom of the window.

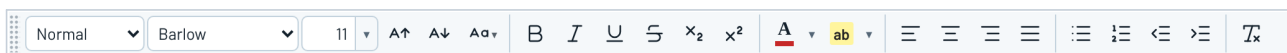
Key or button	Action
Next ►, →, ↓, Space, Enter, Page Down	Show the next region
◀ Previous, ←, ↑, Backspace, Page Up	Hide the last region again
Show all	Reveal everything
Exit, Esc	Leave the presentation

Nothing in the worksheet changes during a presentation, and the bar is never printed.

CHAPTER 14

Text

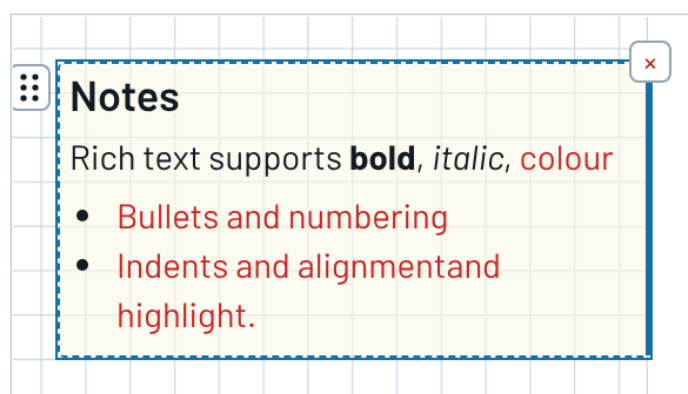
Text blocks hold headings, explanations, assumptions and notes. They are formatted with the Text formatting toolbar.



The Text formatting toolbar.

Control	What it does
Paragraph style	Normal, Heading 1 to Heading 5 or Quote for the current paragraph. How each style looks is set once for the whole worksheet (see Styles below).
Font and size	Any of the listed fonts. For the size, pick one from ▼, type any size (for example 10.5) and press Enter, or turn the mouse wheel over the size box. With text selected, the change applies to the selection; with just the cursor in a word, it applies to that word.
B I U S	Bold (Ctrl+B), italic (Ctrl+I), underline (Ctrl+U), strikethrough.
x ₂ x ²	Subscript and superscript.
A ▼	Text colour. Click A to apply the colour shown; click ▼ to choose another colour.
ab ▼	Highlight (background) colour, the same way.
Alignment	Left, centre, right or justified.
Lists and indents	Bulleted list, numbered list, decrease indent, increase indent.
Bigger / smaller (A↑ A↓)	One size up or down in the size list (Ctrl+] and Ctrl+[).
Change case (Aa ▼)	UPPERCASE, lowercase, Sentence case, Capitalize Each Word, tOGGLE cASE, camelCase, PascalCase, snake_case and kebab-case for the selection (or the word at the cursor). Bold, colours and sizes stay where the text keeps its length.
Clear formatting	Removes fonts, colours and styles from the selection and returns it to Normal.

With one or more text blocks selected (not being edited), a formatting command applies to all their text; a size given this way sets the size of the whole block.

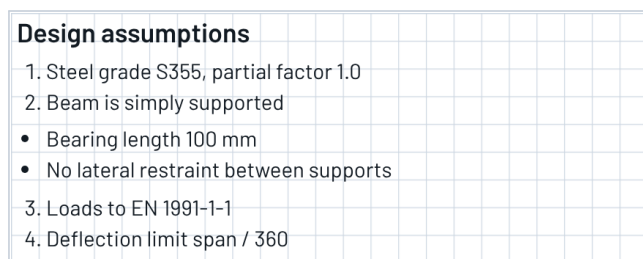


A text block using a heading, bold, italic, colour and bullets.

Lists that number themselves

At the start of a line, type 1. and a space to start a numbered list, or - or * and a space for a bulleted list. Enter starts the next item; Enter on an empty item ends the list. The list buttons on the toolbar do the same.

Bullets placed between numbered items do not restart the numbering: 1, 2, •, •, 3, 4. Typing another number, such as 5., starts a list at that number.



A numbered list that carries on after two bullets.

- Click an empty spot and type " as the first key to start a text block, or use Insert ► Text (T on the Insert toolbar). Any other first key starts a maths line. A maths line always stays a maths line (a " inside it is a text value) and a text block always stays a text block. Press Esc or click elsewhere to finish.
- Click a text block once to select it (and drag it to move it); double-click it to type in it, with the cursor where you clicked.
- Headings use the full width of the block: a long heading fills its first line before it wraps.
- Drag the right edge of a text block to change its width.
- Pasted text arrives as plain text, so it takes the formatting of the place you paste it. Pasting a picture into a text block adds the picture below it.
- The same commands are in the Format menu.

Phrase suggestions

While you type in a text block, Equation Pad suggests the rest of a likely phrase in light grey after the cursor. Press **Tab** to take it; keep typing, or press **Esc**, to ignore it. About 30 000 engineering phrases are built in (materials and their strengths, actions and combinations, effects such as bending moment and shear force, resistances, geometry, geotechnics, mechanical design and the usual report wording), and phrases you write yourself are learnt, in this browser only, so they are offered next time. **Format ► Suggest phrases while typing** switches the suggestions off.



Typing "The characteristic " offers "compressive strength of concrete"; Tab takes it.

A new text block starts about ten characters wide and grows as you type, up to the right margin, where the text wraps. Drag its right edge to give it a fixed width.

Styles for the whole worksheet

A style is set once and used everywhere. Choose **Format ► Styles...**, pick a style on the left (Normal, Heading 1 to Heading 5, Quote) and set its font, size, colour, bold, italic, underline, capitals and the space before and after. Click **Apply**: every paragraph with that style changes at once, so every Heading 2 in the worksheet looks the same. The styles are saved with the worksheet and used in print, PDF and .docx.

Normal

Heading 1

Heading 2

Heading 3

Heading 4

Heading 5

Quote

Font

Default (Barlow)

Size (pt)

16.5

Colour

Automatic

Space before (pt)

0

Space after (pt)

4.5

☒ Bold
 ☐ Italic
 ☐ Underline
 ☐ All capitals

Heading 1: Floor beam B3, span 6 m

Reset this style

Reset all styles

Cancel

Apply

Format ► Styles: change Heading 1 here and every Heading 1 changes.

STYLES AND HAND FORMATTING

Bold, a colour or a size that you apply by hand to some words stays on those words. To change a whole kind of paragraph, change its style instead.

Spelling check

Misspelt words in text blocks get a red underline while you type; right-click a word for suggestions.

Format ► Check spelling while typing switches the underlines on or off. The check is done by your browser with its own dictionary, on your computer: nothing you write is sent anywhere. Maths lines, cell formulas and programs are never spell-checked.

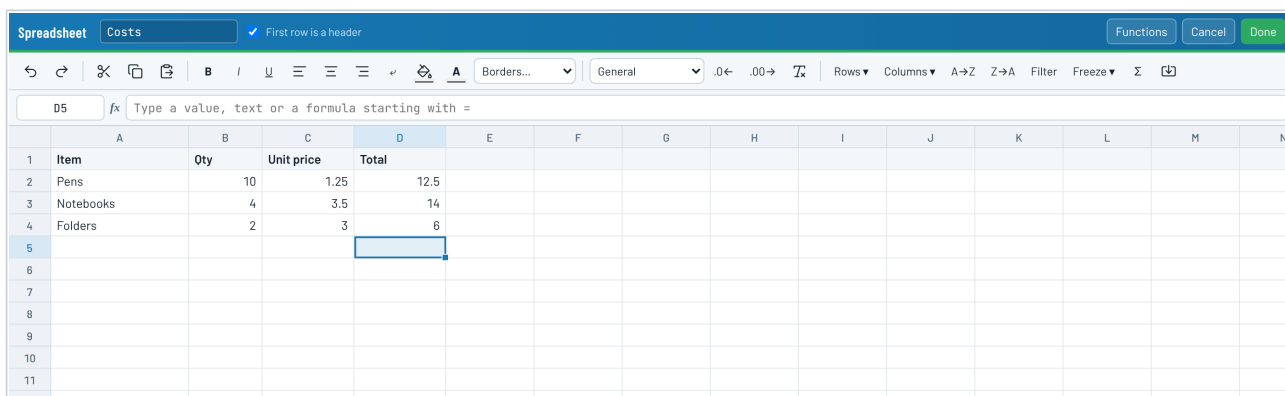
CHAPTER 15

Spreadsheets

A spreadsheet sits right on the sheet, between your maths lines. It opens in its own full-screen editor, like the drawing editor. Cells can hold numbers with units, text, or formulas that use other cells and your worksheet variables, and maths lines below it can read any cell.

The spreadsheet editor

- **Insert ► Spreadsheet** places a spreadsheet and opens the editor. On the sheet, **double-click** a spreadsheet (or right-click ► Open in the spreadsheet editor...) to open it again.
- At the top: the name of the spreadsheet (T1, T2... use it in maths), **First row is a header**, **Functions** (the list of functions, with search), **Cancel** and **Done**. Done puts your changes on the sheet; Cancel leaves the spreadsheet as it was.
- Below: the toolbar, the cell address box and the formula bar, the grid, and the tabs at the bottom.



The spreadsheet editor with the Costs table of the example sheet.

To...	Do this
Type in a cell	Click it and type, or double-click to change what is there. Enter moves down, Tab moves right, Esc cancels. The formula bar shows and edits the cell too. While you type, the box stays inside the cell: long text scrolls inside it and the formula bar shows all of it.
Select cells	Drag across them, or Shift+click or Shift+arrows. Click a column letter or row number for the whole column or row; the corner selects everything.
Fill and continue a series	Drag the small square at the bottom-right of the selection. Numbers like 1, 2 continue as 3, 4, 5; a formula is copied with its references moved along (=B2*C2 becomes =B3*C3). Ctrl+D fills down and Ctrl+R fills right.
Copy, cut and paste	Ctrl+C, Ctrl+X, Ctrl+V. Ranges paste with their formulas moved along. Cells copied from another spreadsheet program paste in as values, and cells copied here paste into other programs.
Undo and redo	Ctrl+Z and Ctrl+Y, for every change in the editor.
Rows and columns	Rows ▼ and Columns ▼ insert or delete them; drag the edge of a column letter to change its width.
Sort and filter	A→Z and Z→A sort the selected rows by the active column. Filter hides the rows that do not match.
Freeze	Freeze ▼ keeps the top row or first column in view while you scroll.

To...	Do this
Format	Bold, italic, underline, alignment, wrap, fill and text colour, borders, number format (general, number, percent, currency, scientific, date, text), and more or fewer decimal places.
Quick total	Σ adds a SUM below or beside the selected numbers. The status line shows the sum, average and count of the selection.
Tabs	+ at the bottom adds a tab. Double-click a tab to rename it; right-click it to move or delete it. Each tab is its own grid.

TABS

All the tabs travel with the spreadsheet. On the sheet you see the first tab, with a note of the other tabs; in a workbook export every tab becomes a worksheet.

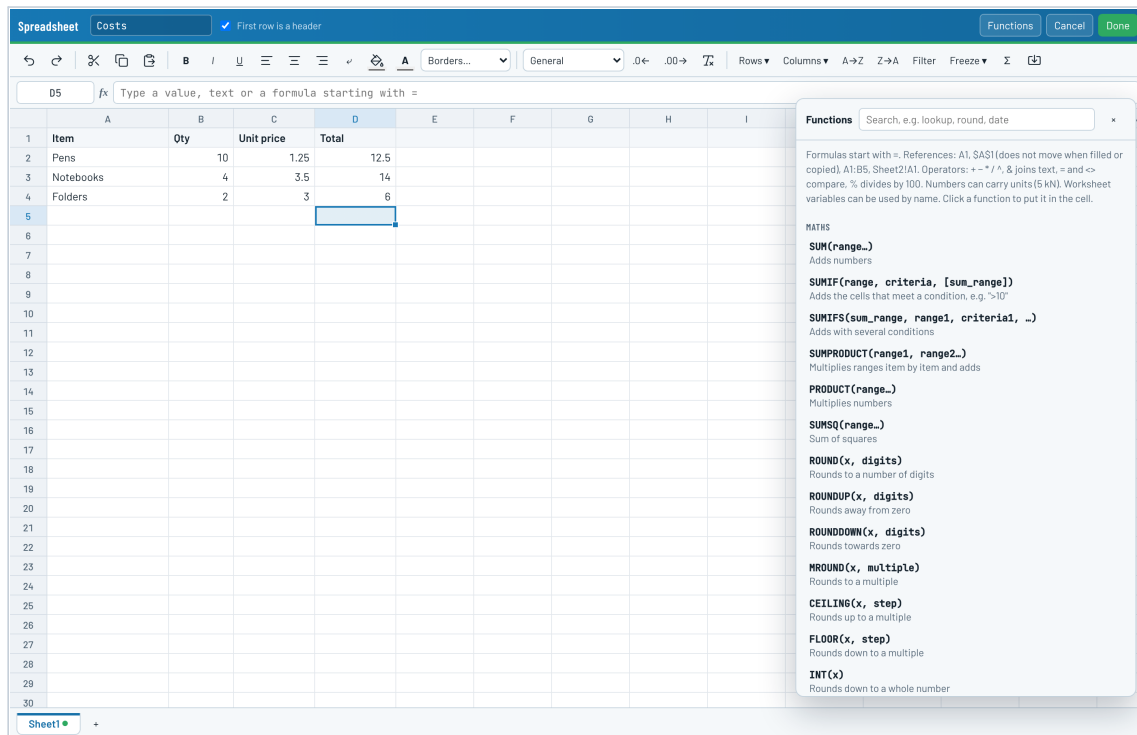
What a cell can hold

Type	Example
A number	1.25
A number with a unit	4.2 kg, 3 m
Text	Notebooks
A formula	=B2*C2, =SUM(D2:D4), =IF(D6>40, "over", "ok"), =VLOOKUP("Pens", A2:C4, 3, FALSE)
A reference that does not move when filled or copied	=B\$1*B2
A cell of another tab	=Sheet2!B3
A formula using worksheet variables	=rate*B2 — rate defined in a maths line above the spreadsheet

VARIABLES IN CELLS

To use a variable in a cell, type = and then click its name in the variable store (or type the name). Only variables defined above the spreadsheet can be used.

Formulas start with =. They can use cell references (B2, \$B\$2), ranges (B2:D4), other tabs (Sheet2!B3), more than a hundred spreadsheet functions (maths, statistics, logic, lookup, text, date, information and money; click **Functions** for the list with a search box) and every maths function. Errors show as #DIV/0!, #N/A, #NAME?, #REF!, #NUM! or #VALUE!.



Functions: every function with its arguments; click one to put it in the cell.

Building a formula by clicking cells

You do not need to type cell references:

- 1 Click the cell for the result and type = followed by the start of the formula, for example =sum(.
- 2 Click another cell: its reference (for example D2) is inserted at the cursor. The picked cell gets a moving dotted border (green and dashed in a spreadsheet on the sheet).
- 3 Drag across several cells instead to insert a range, such as D2:D4.
- 4 Type the next operator (for example * or +) and click the next cell. Clicking again straight after a pick replaces that pick, so you can correct a wrong click.
- 5 Press **F4** to fix the reference at the caret: A5 becomes \$A\$5, then A\$5, then \$A5, then A5 again. A \$ keeps that part fixed when the formula is copied or filled.
- 6 Press Enter to finish.

D2		fx =B2*\$C\$2				
	A	B	C	D	E	F
1	Load	Value	Factor	Design		
2	Dead	25	1.35	=B2*\$C\$2		
3	Imposed	12	1.5			

B2 picked and C2 fixed with F4: the picked cell has a moving dotted border.

Cells of another spreadsheet can be picked too; its name is added for you, for example Prices!B3. A spreadsheet must be above the spreadsheet or line that reads it.

Using spreadsheet values in maths

Write in a maths line	Gives
<code>q := Costs!B3</code>	The value of cell B3 of the spreadsheet named Costs (Costs.B3 also works).
<code>Costs!D2:D4</code>	A range, as a matrix (here a column of three values).
<code>Costs!Sheet2!B3</code>	Cell B3 of the tab named Sheet2.
<code>total := sum(Costs!D2:D4) =</code>	A total of a range.
<code>Costs</code>	The whole spreadsheet (without the header row) as a matrix, e.g. Costs[2, 4].

TIP

While typing a maths line, click any spreadsheet cell to insert its reference, or drag across cells for a range.

Spreadsheet files: .xlsx and .csv

To...	Do this
Bring in a table from a file	Insert ► Spreadsheet from a file , or Import... on the Spreadsheet toolbar, and pick a .xlsx workbook or a .csv file. The first worksheet of a workbook is read, as values (up to 500 rows × 52 columns). A header row is recognised.
Fill an existing spreadsheet	Right-click it ► Import from a file . Its cells are replaced (Undo brings them back).
Save one spreadsheet	Right-click it ► Save as .xlsx workbook or Save as .csv file (or .xlsx... and .csv... on the toolbar).
Save all spreadsheets at once	File ► Export ► All spreadsheets : one .xlsx workbook with a worksheet for each spreadsheet, named after it.

Values are exported as they are shown. Numbers stay numbers; a unit is kept as the cell's number format (so 12.5 kN is the number 12.5 shown as "12.5 kN"). Bold, italic, fill and text colours, alignment, decimal places, column widths and the header row go with them. Formulas stay in Equation Pad; the exported file holds their results. In .csv files commas, semicolons and tabs are all recognised.

CHAPTER 16

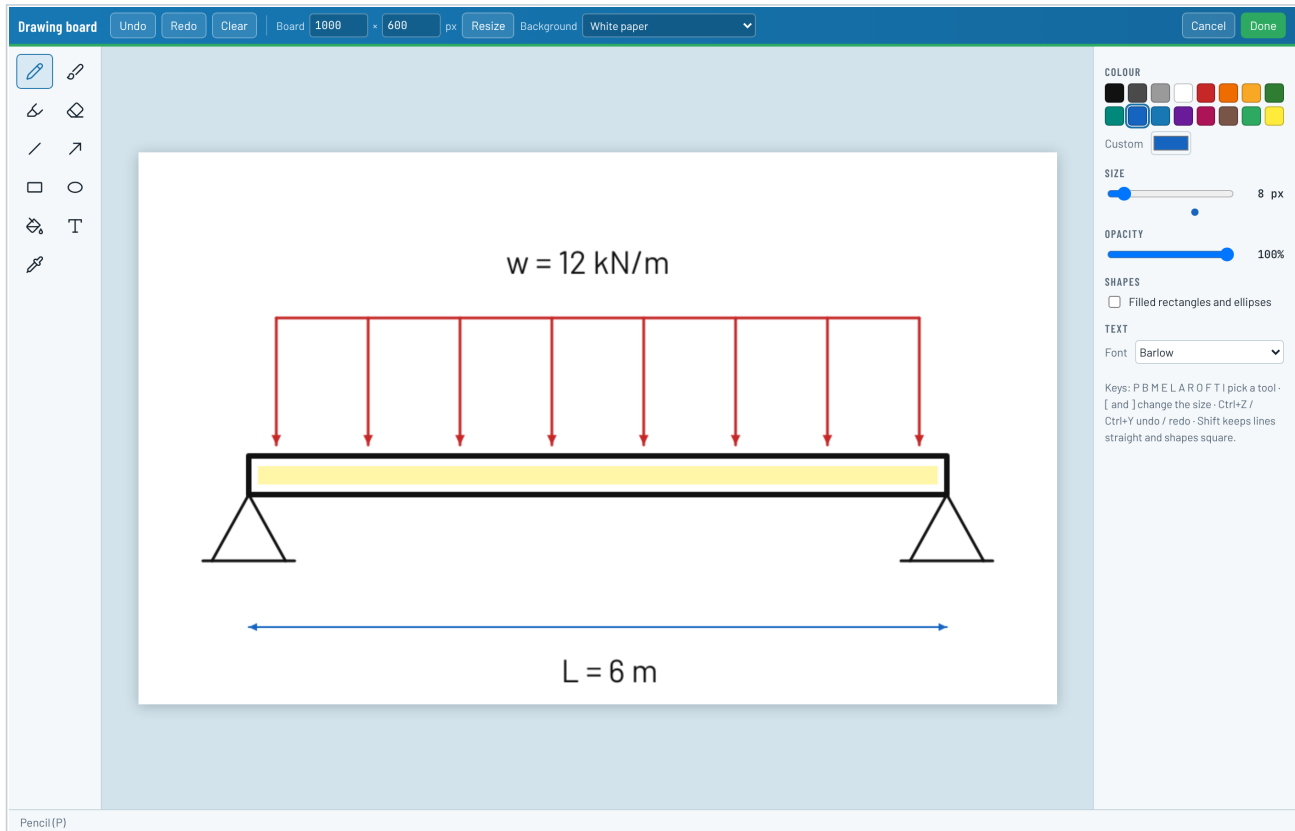
Pictures

- **Insert ► Picture** places a JPEG, PNG, GIF, WebP or SVG at the cursor.
- You can also paste a picture (Ctrl+V) or drag a picture file onto a sheet.
- Drag the blue square at the bottom right of a selected picture to resize it; it keeps its proportions.
- Very large photos are reduced automatically so the worksheet file stays small.
- The company logo is not a picture region: it lives in the title block (chapter 4).

CHAPTER 17

Drawing board (sketches)

Insert ► Drawing board places a sheet of paper for free-hand sketching and painting next to your calculation: a load diagram, a section, a site sketch, a quick idea.

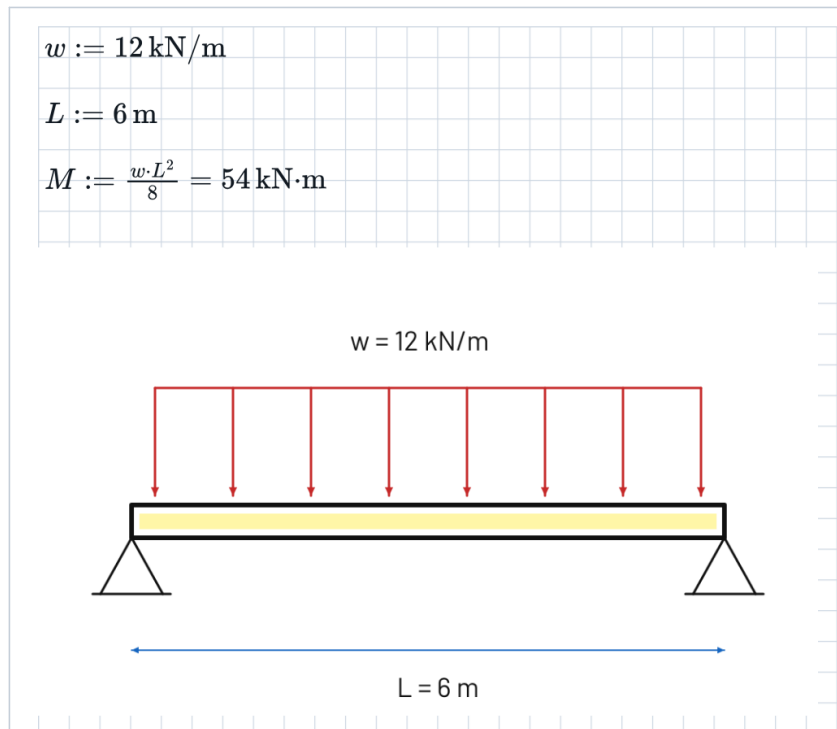


The drawing board: tools on the left, colour, size and opacity on the right.

Tool (key)	What it does
Pencil (P)	A thin line that follows the pointer.
Brush (B)	A softer, wider line; with a pen it gets thicker the harder you press.
Marker (M)	A see-through highlighter: strokes do not darken where they overlap.
Eraser (E)	Rubs out what is under it.
Line (L) · Arrow (A)	Straight lines and arrows. Hold Shift for 0°, 45° and 90°.
Rectangle (R) · Ellipse (O)	Outlines, or filled shapes when “Filled rectangles and ellipses” is ticked. Hold Shift for squares and circles.
Fill (F)	Fills a closed area with the colour.
Text (T)	Click where the text goes, type, press Enter. The size slider sets the letter height.
Colour picker (I)	Takes a colour from the board.

- Pick a colour from the swatches or choose any colour with Custom. Size and Opacity are sliders; [and] change the size from the keyboard.
- Undo and Redo (Ctrl+Z, Ctrl+Y) step through every stroke; Clear empties the board.
- Board sets the size of the drawing in pixels (1000 × 600 to start); Resize keeps what is drawn. Background is white paper, or transparent so the sheet grid shows through.

- Click **Done** to put the drawing on the sheet, or Cancel to leave it unchanged. Double-click it later (or select it and press Enter) to carry on drawing.
- On the sheet a drawing board is like a picture: drag it to move it, drag its corner square to resize it. It prints and goes into PDFs and .docx documents.
- Your last tool, colour and size are remembered in this browser.

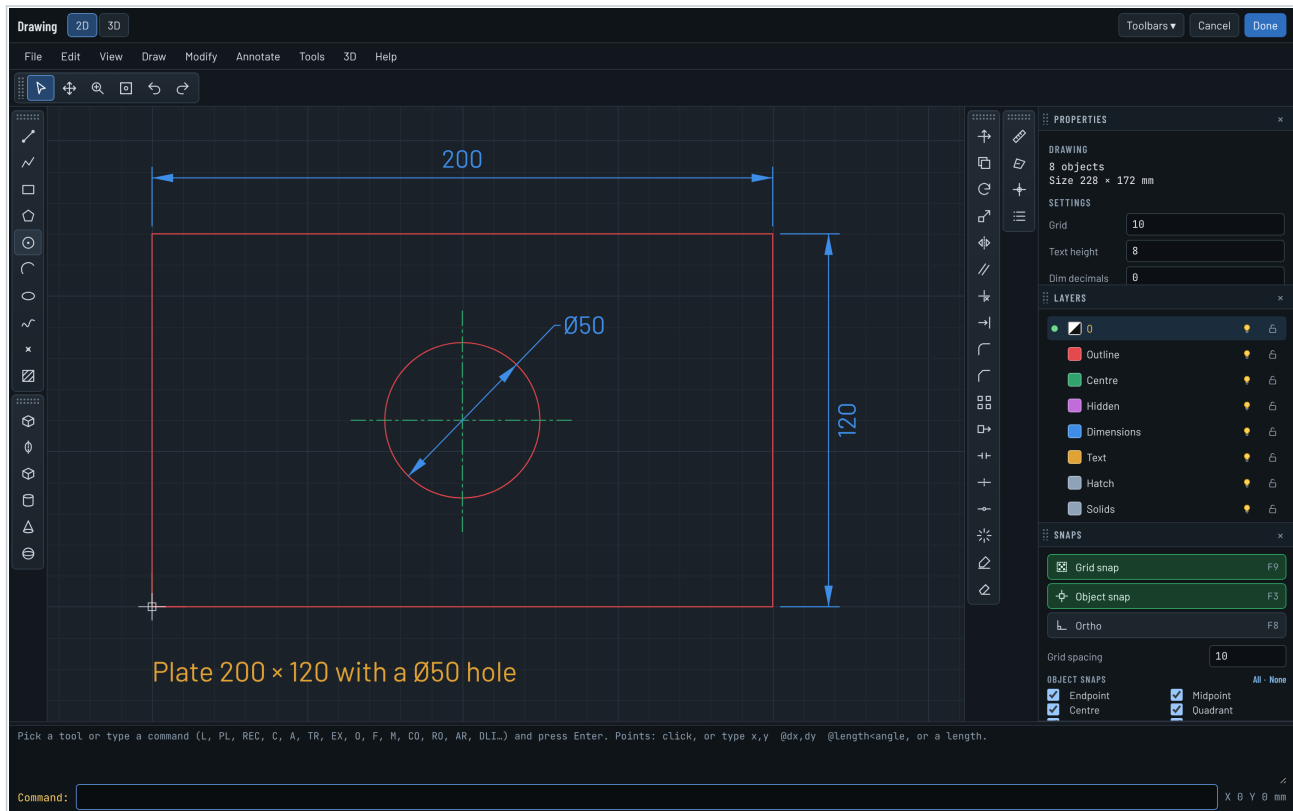


The sketch on the sheet, next to the calculation it explains.

CHAPTER 18

Drawings (2D and 3D CAD)

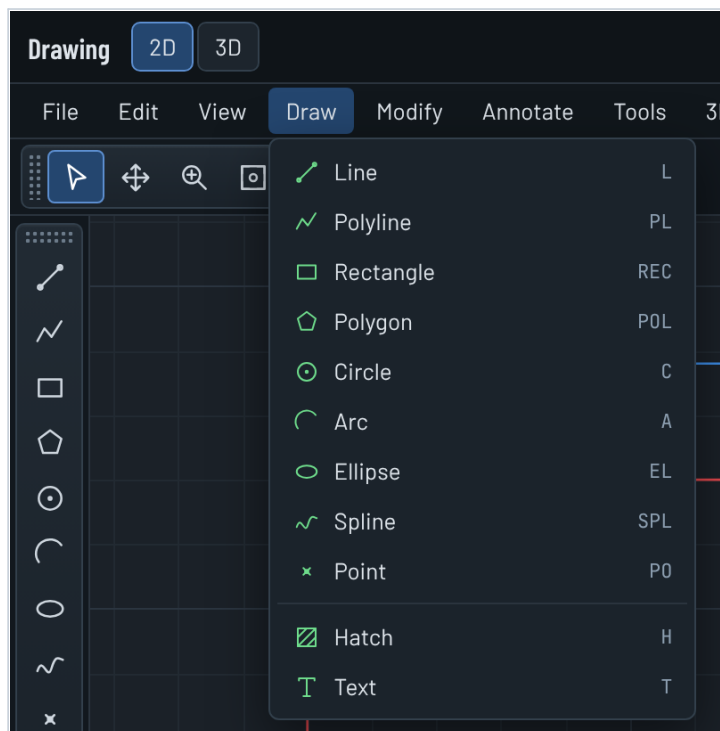
Insert ► Drawing places a CAD drawing on the sheet. Double-click it to open the drawing editor: a full-screen model space with typed commands, dockable toolbars, object snaps, grips, layers, dimensions, hatching and a 3D view.



The drawing editor: the menu bar, the Standard toolbar, Draw and 3D solids on the left, Modify and Inquiry on the right, the Properties, Layers and Snaps windows at the far right and the command line at the bottom.

The menu bar and the tool windows

Every command is in the menu bar of the editor: **File** (Done, Cancel), **Edit** (undo, redo, cut, copy, paste, select all, erase), **View** (2D or 3D, zoom, Toolbars ►, Windows ►, reset the layout), **Draw**, **Modify**, **Annotate**, **Tools** (distance, area, Layer Properties, hatch settings, grid snap, object snap, ortho), **3D** and **Help** (all commands with their short names). The short name to type is shown next to each command.



The Draw menu, with the short names to type.

Window	What it holds
Properties	With nothing selected: the size of the drawing, grid, text height, dimension decimals and arrows. With objects selected: their exact coordinates, lengths, areas and volumes, layer, colour and linetype, all of which you can type.
Layers	Every layer with its colour. Click a layer to make it current; the light bulb shows or hides it and the padlock locks it. New layer, and Layer Properties... for the full table.
Snaps	Grid snap (F9), object snap (F3) and ortho (F8) as switches, the grid spacing, and each object snap (endpoint, midpoint, centre, quadrant, intersection, perpendicular, node, nearest) with All and None.
Hatch	The patterns with pictures, scale, angle, colour and layer. Pick a pattern here, then Hatch (H) and click inside shapes. Hidden at first: View ► Windows ► Hatch, or Tools ► Hatch settings.

- Drag a window by its title bar: drop it near the left or right edge of the drawing to dock it there (several windows stack in a column), or anywhere else to float it. Double-click the title bar to switch between floating and docked.
- × hides a window; **View ► Windows** brings it back. **View ► Reset toolbars and windows** returns to the standard layout, which is remembered in this browser.

Toolbars

Toolbar	Contents
Standard	Select, pan, zoom window, zoom extents, undo, redo.
Draw	Line, polyline, rectangle, polygon, circle, arc, ellipse, spline, point, hatch.
Modify	Move, copy, rotate, scale, mirror, offset, trim, extend, fillet, chamfer, array, stretch, break, break at point, join, explode, match properties, erase.
Annotate	Text and the dimension types, leader. Hidden at first.
Inquiry	Distance, area, point coordinates, list.
3D solids	Extrude, revolve, box, cylinder, cone, sphere.
Drafting	Snap to grid (F9), object snap (F3), ortho (F8). A green button is on. Hidden at first; the F keys always work.
Layers	The current layer, and Layer Properties. Hidden at first.

- Every toolbar can be docked at the top, bottom, left or right of the drawing area, or float over it: drag it by its dotted handle. The side that will take it is outlined while you drag. Double-click the handle to switch between floating and docked.
- Right-click any toolbar, or use **Toolbars ▼** in the top bar, to show or hide toolbars (Annotate, Drafting and Layers start hidden) or to reset the layout. The layout is remembered in this browser.
- A tall toolbar docked on a side wraps into two or three columns when the window is short. **Properties** in the top bar shows or hides the Properties window.
- While you draw, the shape being drawn follows the pointer as a solid line.

Working in the editor

- Pick a tool on a toolbar, or type a command at the bottom and press Enter or Space. Enter on its own repeats the last command; Esc cancels; right-click acts as Enter.
- Points: click, or type **x,y** (absolute), **@dx,dy** (relative) or **@length<angle** (polar). A plain number goes that far in the direction of the cursor.
- Lines can also be drawn by pressing the mouse button at the start, dragging and releasing at the end; every next segment starts at the last end point.
- Lines and polylines: **C** closes the shape back to its first point once there are at least two segments; **U** undoes the last segment. After Esc, press Enter (repeats the command) and Enter again to go on from the last point.
- Object snaps show a green marker: endpoint, midpoint, centre, quadrant, intersection, perpendicular, node and nearest (choose them in the Snaps window). Grid (F9), Osnap (F3) and Ortho (F8) are switches in the Snaps window and on the Drafting toolbar and work from the keyboard even when it is hidden.
- Select by clicking or with a window: dragging left to right selects objects fully inside, right to left selects anything touched. Shift+click adds or removes. Selected objects show blue grips you can drag.
- The Properties window shows exact coordinates, lengths, areas and volumes and lets you type new values, colour and linetype. Ctrl+C / Ctrl+V copy and paste inside the drawing.
- Click **Done** to return to the sheet. The drawing appears at the width you set by dragging its corner.

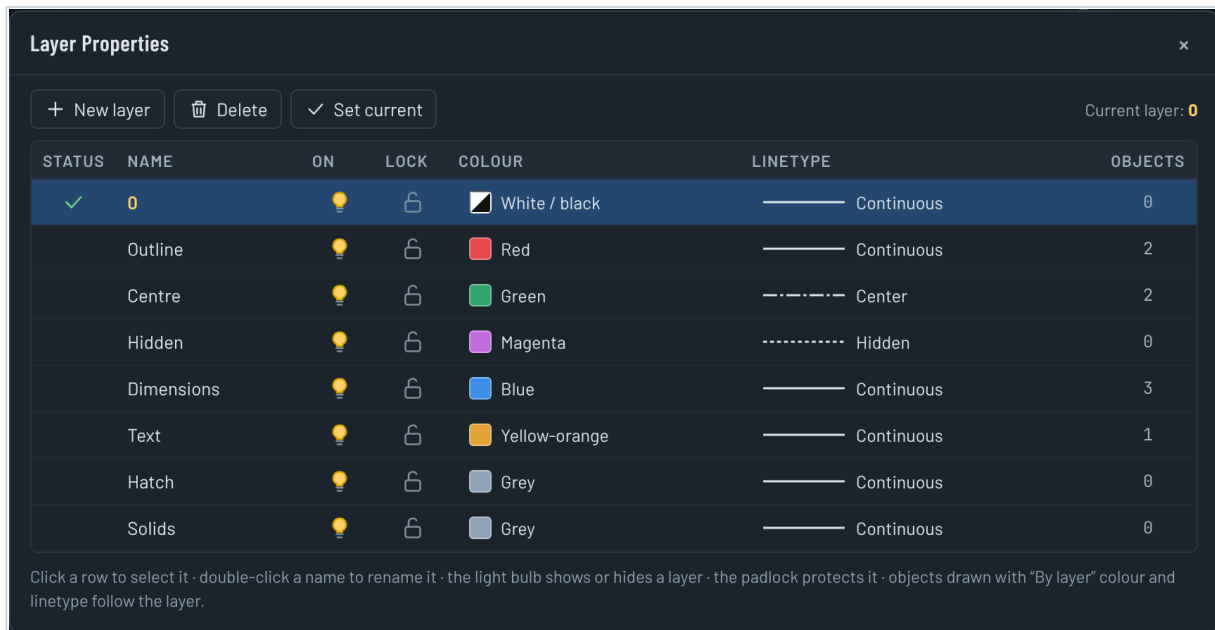
Command reference

Draw	Type	Annotate	Type
Line	L	Text	T
Polyline	PL	Linear dimension	DLI
Rectangle	REC	Aligned dimension	DAL
Polygon	POL	Angular dimension	DAN
Circle (2P, 3P options)	C	Radius / diameter dim.	DRA DDI
Arc (3 points; C = centre)	A	Leader	LE
Ellipse	EL	Hatch (pattern, scale, angle)	H
Spline	SPL	Point	P0
Modify	Type	Modify / inquiry	Type
Move	M	Array (rectangular, polar)	AR
Copy (repeats)	C0	Stretch	S
Rotate	R0	Break / break at point	BR BA
Scale	SC	Join	J
Mirror	MI	Explode	X
Offset	O	Match properties	MA
Trim	TR	Erase	E
Extend	EX	Distance / area	DI AA
Fillet (R = radius)	F	Point id / list	ID LI
Chamfer (D = distances)	CHA	Zoom extents / window, pan	ZE ZW P
Undo / redo	U REDO	Layers	LA

Long names work too: LINE, CIRCLE, OFFSET, FILLET, DIMLINEAR and so on.

Layer Properties

Type **LA**, click **Layer Properties...** in the Layers window, or use Tools ► Layer Properties. A table lists every layer, like other CAD programs:



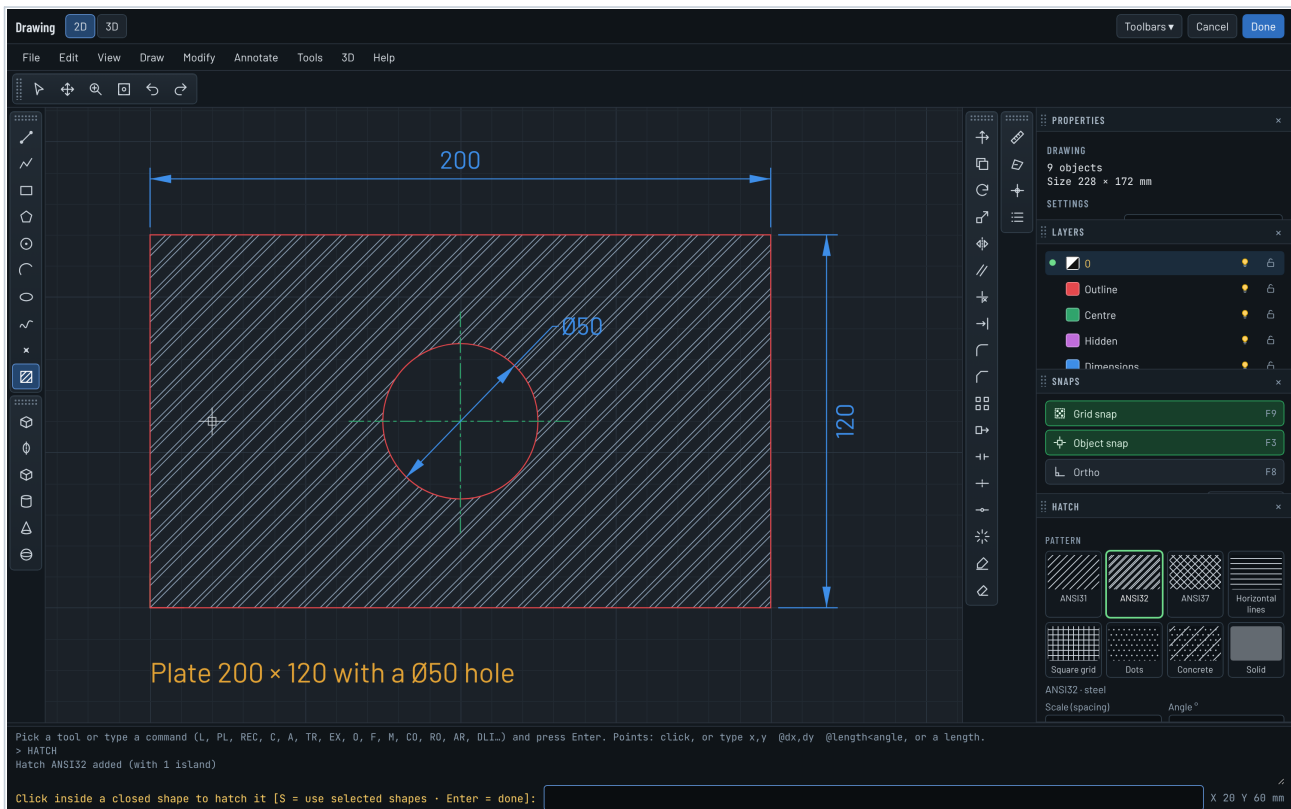
Layer Properties: on/off, lock, colour, linetype and how many objects each layer holds.

Column or button	What it does
Status ✓	The current layer: new objects are drawn on it. Select a row and click Set current to change it.
Name	Double-click to rename. Layer 0 cannot be renamed or deleted.
On (light bulb)	Shows or hides everything on the layer. Hidden layers are not printed.
Lock (padlock)	Locked objects can be seen and snapped to, but not selected or changed.
Colour · Linetype	Click to choose from the list. Objects whose colour and linetype are "By layer" follow the layer.
Objects	How many objects are on the layer.
New layer · Delete	New adds a layer and lets you name it; Delete removes a layer that holds no objects.

Layers 0, Outline, Centre, Hidden, Dimensions, Text, Hatch and Solids are ready to use. Dimensions, text, hatches and solids go to their own layers automatically while layer 0 is current.

Hatching

Click the Hatch button or type **H**. The Hatch panel (or the Hatch window, when it is open) shows pictures of the patterns: ANSI31 (general and brick), ANSI32 (steel), ANSI37 (cross-hatch), horizontal lines, square grid, dots (sand), concrete and solid fill.



The Hatch window docked on the right: pick a pattern, set scale and angle, then click inside shapes.

- 1 Pick a pattern, and if you like a scale (the spacing; empty means automatic), an angle, a colour and a layer.
- 2 Click inside a closed shape: rectangle, closed polyline, polygon, circle, ellipse or closed spline. It is filled at once; shapes lying inside it stay open (islands).
- 3 Click inside more shapes, or select shapes and click **Use selected shapes**. Changing the pattern or scale now changes the last hatch too.
- 4 Press Enter or close the panel to finish. To change a hatch later, select it and click **Edit hatch...** in Properties.

The command history above the command line keeps every message of the session: scroll it with the mouse wheel, or drag its corner to make it taller.

3D

Press **3D** in the top bar. Make solids with **BOX**, **CYL**, **CONE** and **SPHERE**, or turn closed 2D shapes into solids with **EXT** (extrude by a height) and **REV** (revolve about an axis). Drag to orbit, right-drag to pan, use the Top, Front, Right and Iso views, and pick a visual style: shaded with edges, shaded, wireframe or X-ray. Move, copy, rotate, scale and mirror also work on solids. If you finish in 3D, the sheet shows a picture of the model; finish in 2D for a plan with dimensions.

CHAPTER 19

Result format and calculation

Setting (Format ► Result format and units)	Effect
Unit system for results	Engineering SI (kN, m, mm, MPa), SI base units, or US customary. Used for combined units when you do not ask for a unit.
Number format	Significant figures (2-10) or a fixed number of decimal places (0-8). Very large and very small numbers use powers of ten.
Calculate automatically	On: results update as you work. Off: press F9 (Calculate ► Recalculate now) when you want fresh results; old results are greyed.
Matrix display limits	The largest matrix shown in full (rows and columns).

A single line can use its own format: right-click it ► Result format for this line (chapter 12).

Undo (Ctrl+Z) and Redo (Ctrl+Y) cover every change, including moves, deletions, page setup and the title block.

CHAPTER 20

Files, printing and export

Command	What it does
File ► Save (Ctrl+S)	Saves the worksheet as an .eqnpad file. It keeps every region, drawing, table, picture, the logo, your own units, page setup and result settings.
File ► Save as (Ctrl+Shift+S)	Saves under a new name. The suggested name comes from “Calculation for”.
File ► Open (Ctrl+O)	Opens an .eqnpad worksheet. Worksheets from earlier versions open too, and are brought up to date.
File ► Export ► PDF (PDF button)	Makes a PDF of all sheets straight away, at true paper size, with the title block, logo, grid and footer, and saves it. No print dialog is needed.
File ► Share...	Sends the worksheet as a PDF (for reading) or an .eqnpad file (for editing): by your device's share menu (WhatsApp, email, Teams, AirDrop... where the browser offers it), by email, by WhatsApp, or simply saved.
File ► Print (Ctrl+P)	Prints the sheets at true paper size, with the title block, grid (if set to print) and footer.
File ► Export ► Document (.docx)	Writes the worksheet as a .docx document for word processors: the title block as a table, text as real paragraphs (headings, bold, colours, lists), spreadsheets as real tables, and maths, graphs, programs, pictures, drawings and sketches as pictures, in sheet order. Page size and margins follow Page setup.
File ► Export ► Web page	Writes the finished sheets as one web page that anyone can open without the app.
File ► Export ► All spreadsheets (.xlsx)	Every spreadsheet in one .xlsx workbook (see the Spreadsheets chapter).
File ► New worksheet	Starts a blank worksheet with the standard settings: A4 portrait, standard margins, grid, footer and captions, and the standard result format. Only your company logo is kept.

	PROJECT Equation Pad examples	JOB NO. EP-001	SHEET 1
	CALCULATION FOR Feature tour	REVISION 0	
	CALCULATED BY	DATE 09/10/2026	CHECKED BY
		DATE	APPROVED BY
		DATE	DATE

Equation Pad: a quick tour

Double-click any line to edit it; everything below updates. Drag a line to move it. Click an empty spot and start typing to add maths, or type " for text. Enter on the sheet adds space; Backspace and Delete remove it. Point at any button to see what it does in the status bar.

1. Values, units and conversion

$d := 120 \text{ km}$

$t := 1.5 \text{ h}$

$v := \frac{d}{t} = 80 \text{ km/h}$

$v = 22.22 \text{ m/s}$

$g := -\frac{1}{3} + \frac{2}{3} = 0.3333$

2. Functions and calculus

$f(x) := 3 \cdot x^2 - 2 \cdot x + 1$

$\int_0^2 f(x) dx = 6$

$\frac{d}{dx} f(x) = 10$

CREATED USING THE BETA VERSION OF EQUATION PAD. VI

The first page of an exported .docx document, with the beta text down the right margin.

	PROJECT Equation Pad examples				JOB NO. EP-001	SHEET 1 of 2
	CALCULATION FOR Feature tour				REVISION 0	
	CALCULATED BY A. Author	DATE 07/10/2026	CHECKED BY B. Checker	DATE 08/10/2026	APPROVED BY C. Approver	DATE 09/10/2026

Equation Pad: a quick tour

Click any line to edit it; everything below updates. Click an empty spot and start typing to add maths, or type " for text. Enter on the sheet adds space; Backspace and Delete remove it. Point at any button to see what it does in the status bar.

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2. Functions and calculus

$$f(x) := 3 \cdot x^2 - 2 \cdot x + 1$$

$$\int_0^2 f(x) dx = 6$$

$$\left. \frac{d}{dx} f(x) \right|_{x=2} = 10 \qquad \sum_{k=1}^{10} k^2 = 385$$

3. Matrices

Commas separate columns and semicolons separate rows. **[A, b]** joins side by side; **[A; B]** stacks.

$$A := \begin{bmatrix} 4 & -2 \\ 1 & 1 \end{bmatrix} \qquad b := \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

$$x := \text{lusolve}(A, b) = \begin{bmatrix} 1.333 \\ 1.667 \end{bmatrix} \qquad \det(A) = 6$$

$$C := [A \ b] = \begin{bmatrix} 4 & -2 & 2 \\ 1 & 1 & 3 \end{bmatrix} \qquad \begin{bmatrix} A \\ 0 \ 1 \end{bmatrix} = \begin{bmatrix} 4 & -2 \\ 1 & 1 \\ 0 & 1 \end{bmatrix}$$

4. Tables and checks

Cell formulas start with =. While typing one, click another cell to insert its reference.

EQUATION PAD EXAMPLES · EP-001 · FEATURE TOUR SHEET 1 OF 2 WWW.EQUATIONPAD.COM

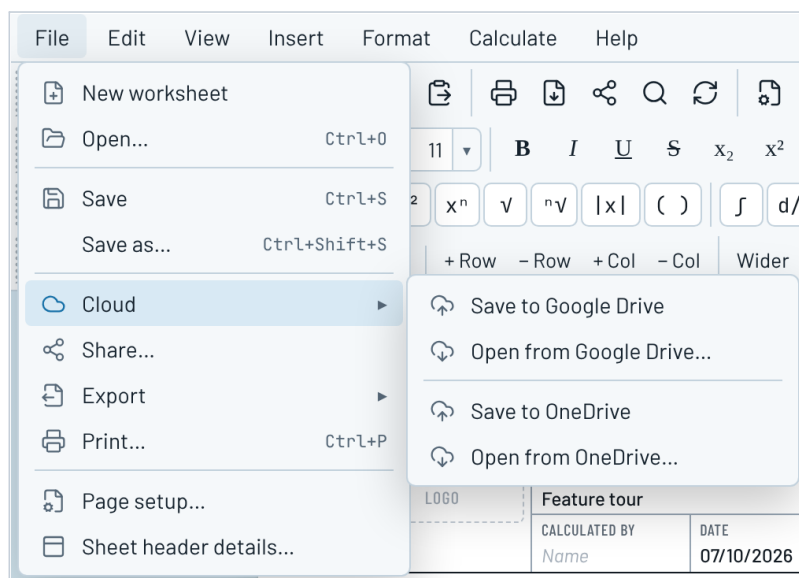
A sheet as it prints and as it appears in the PDF: title block with logo, box grid, typeset maths and footer.

The beta text in the right margin

While Equation Pad is in beta, every printed sheet, PDF, web page and .docx document carries one light line of text down the whole right margin: **“Created using the beta version of Equation Pad. Visit www.equationpad.com to know more”**. It sits in the margin, clear of the calculation, in a pale grey that does not compete with your work, and it is not shown on screen while you work.

Saving to Google Drive or OneDrive

File ► Cloud has four items: Save to Google Drive, Open from Google Drive, Save to OneDrive and Open from OneDrive. Once direct cloud saving is switched on for equationpad.com, they save the worksheet straight to your own drive and open worksheets from there, as described below. Until then they still work the simple way: **Save** keeps the file on your computer and opens your drive in a new tab, where you drag the file in; **Open** opens your drive so you can download the worksheet, then the file window to open it.

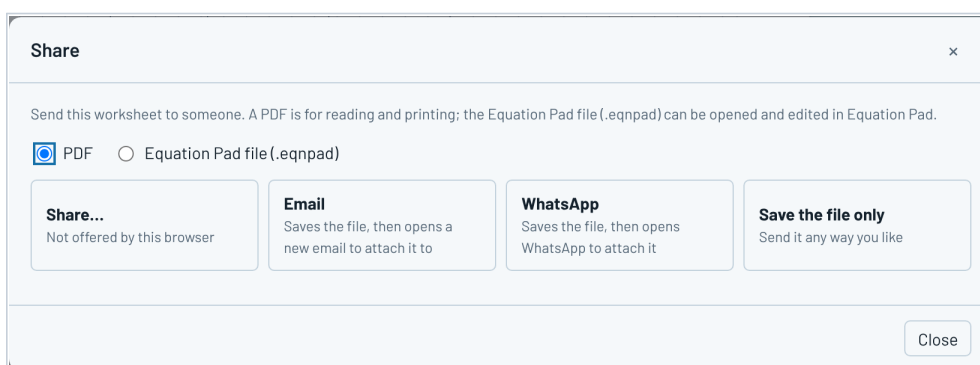


File ► Cloud.

- 1 Choose **File ► Cloud ► Save to Google Drive** (or **Save to OneDrive**).
- 2 The first time, a Google or Microsoft window asks you to sign in and to allow Equation Pad to save files. This happens once per session.
- 3 The worksheet is saved in a folder called **Equation Pad** in your drive. Saving again updates the same file.
- 4 To open one later, choose **Open from Google Drive...** or **Open from OneDrive...** and pick the file.

The file goes directly from your browser to your own account; it never passes through equationpad.com. The sign-in is forgotten when you close the tab. Pop-up windows must be allowed for equationpad.com for the sign-in window to appear.

Sharing

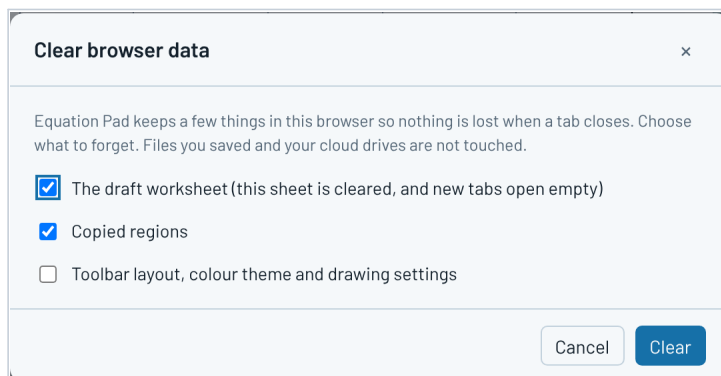


File ► Share: choose PDF or .eqnpad, then how to send it.

Email and WhatsApp cannot receive a file directly from a web page, so Equation Pad first saves the file and then opens a new email or WhatsApp with a short message; attach the saved file from your Downloads folder. The **Share...** button skips that step on devices that offer a share menu (most phones, Windows, ChromeOS and Macs). Some devices can share PDFs but not .eqnpad files; the dialog tells you if so.

Drafts, tabs and Clear browser data

A tab opened while another Equation Pad tab is already open starts with an empty sheet and keeps its own draft, so it never carries the other tab's worksheet. **File ► Clear browser data** (also in Help) forgets what Equation Pad keeps in this browser: the draft worksheet, copied regions, and, if you tick it, the toolbar layout, colour theme and drawing settings. Files you saved and your cloud drives are not touched.



File ► Clear browser data.

The app keeps a draft of the current worksheet in the browser, so closing the tab by accident loses nothing. The draft lives only on that computer and browser: save a file to keep your work safely or to move it to another computer.

IF THE PDF BUTTON DOES NOT WORK

If a browser cannot make the PDF directly (some older Safari versions), Equation Pad offers Print instead: choose "Save as PDF" as the printer.

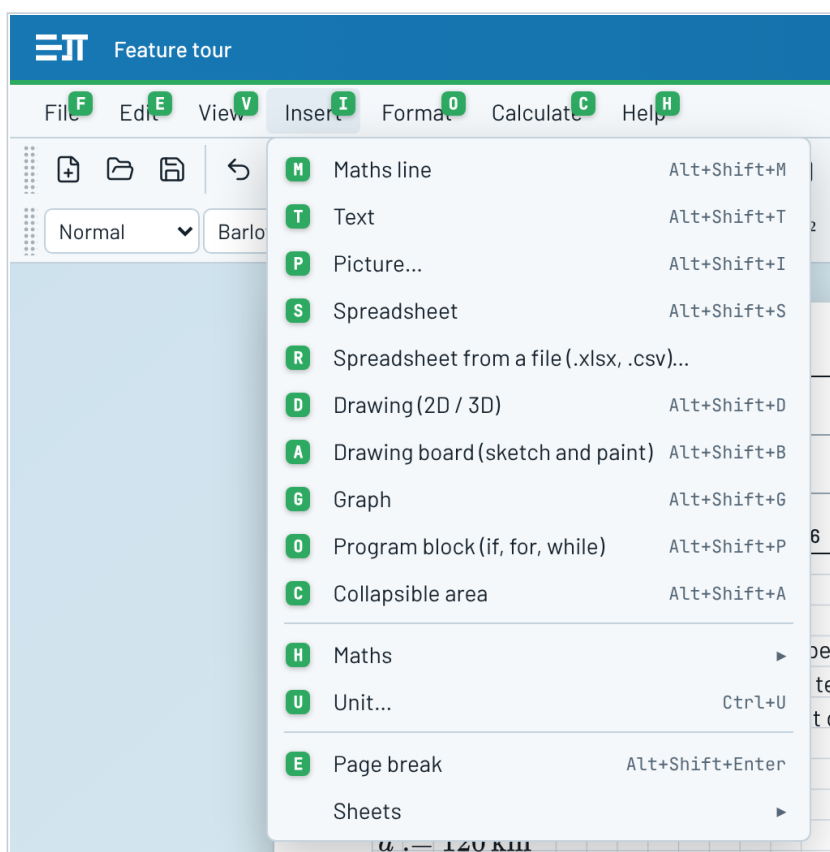
CHAPTER 21

Keyboard shortcuts

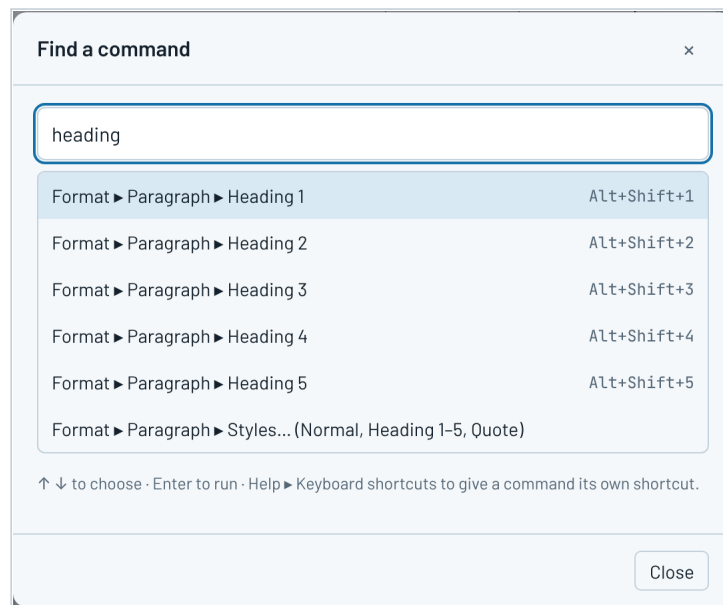
Every command can be reached from the keyboard, in three ways: its own shortcut, the menu letters, or the command search.

Three ways to every command

- **Shortcuts.** The usual ones (Ctrl+S, Ctrl+O, Ctrl+Z...) and Alt+Shift shortcuts for the most used commands, shown next to each command in the menus. For example Alt+Shift+M maths line, Alt+Shift+T text, Alt+Shift+S spreadsheet, Alt+Shift+D drawing, Alt+Shift+G graph, Alt+Shift+E PDF, Alt+Shift+0 to 5 Normal and Heading 1 to 5.
- **Menu letters.** Tap **Alt** on its own: every menu shows a green letter. Press the letters in turn (Alt, I, S = Insert ► Spreadsheet). Esc stops.
- **Find a command.** Press **Ctrl+/,** (Help ► Find a command), type a few letters of any command and press Enter.



After tapping Alt and I: each command of the Insert menu has a letter.



Ctrl+/ finds a command by name.

Your own shortcuts

Help ► Keyboard shortcuts lists every command with its shortcut. Click **Change** and press the keys you want (with Ctrl, Alt or a function key); Backspace removes a shortcut and **Reset** brings back the standard one. If the keys belong to another command they move to the new one. Shortcuts the browser keeps for itself, such as Ctrl+T (new tab) or Ctrl+W (close tab), cannot be used. Your shortcuts are kept in this browser.

Keyboard shortcuts

Tap **Alt** on its own and the menus show a letter for every command (Alt, I, S = Insert ► Spreadsheet). **Ctrl+/,** finds any command by name. Click **Change** and press the keys you want for a command; your shortcuts are kept in this browser.

Command	Shortcut	
Edit ► Space ► Insert space at cursor	Enter	Change
Insert ► Maths line	Alt+Shift+M	Change
Insert ► Text	Alt+Shift+T	Change
Insert ► Picture...	Alt+Shift+I	Change
Insert ► Spreadsheet	Alt+Shift+S	Change
Insert ► Spreadsheet from a file (.xlsx, .csv)...	none	Change
Insert ► Drawing (2D / 3D)	Alt+Shift+D	Change
Insert ► Drawing board (sketch and paint)	Alt+Shift+B	Change
Insert ► Graph	Alt+Shift+G	Change

On the sheet

Click the sheet, then type	Start a maths line at that spot
" (red cross on empty paper)	Start a text region. Any other key starts a maths line; a maths line stays maths and a text region stays text
Enter (in maths)	Finish and move below
Enter (red cross on empty paper)	Insert space; everything below moves down

Reset all shortcuts
Close

Help ► Keyboard shortcuts: filter the list and change any shortcut.

Showing key presses

View ► Show key presses (on at first, at Extra large; switch it off in the same place) shows a small label at the bottom left for every shortcut (written as Ctrl+T), special key (Enter, Esc, Tab, arrows...), mouse click, double-click or scroll, and what you type, gathered in one label while you keep typing. It fades in and out, in the colours of your theme. **View ► Key press size** chooses Small, Medium, Large or Extra large. It is useful for demonstrations, teaching and screen recordings.

Left click

Ctrl+Z

Alt+Shift+G

$$\int_0^2 f(x) dx = 6$$

$$\frac{d}{dx} f(x) \Big|_{x=2} = 10$$

3. Matrices

Commas separate co

Sheet 1 of 2
27 regions · 1 selected
No errors
Maths: x = 5 de

View ► Show key presses.

On the sheet

Keys	Action
F1	Open or close the “How do I...?” help
Click the sheet, then type	Start a maths line at that spot
" (on the sheet)	Start a text block
Enter (in maths)	Finish the line and move below it
Esc (in maths)	Cancel the edit
Tab (suggestions open)	Insert the highlighted suggestion
Tab (grey suggestion in text)	Take the suggested phrase
Alt (tap on its own)	Show the menu letters
Ctrl+/	Find a command by name
Enter / Backspace / Delete (on the sheet)	Add space / remove space above / remove space below
Arrow keys	Move the cross, or nudge selected regions
Enter (red cross on a region)	Edit that region; Enter twice within 1.5 s adds space instead
Double-click a region	Edit it
Drag a region	Move it
1. / - / * then Space (in text)	Start a numbered or bulleted list
Shift+click, drag a box	Select several regions
Delete (regions selected)	Delete them
Ctrl+B / Ctrl+I / Ctrl+U (in text)	Bold / italic / underline
Ctrl+= (in maths)	Plain equals sign $=$
Tab (in a spreadsheet cell)	Move to the next cell
Right-click a cell	Spreadsheet options
= in a cell, then click or drag cells	Build a formula with references
Ctrl+Z / Ctrl+Y	Undo / Redo
Ctrl+X / Ctrl+C / Ctrl+V	Cut / Copy / Paste
Ctrl+A	Select all regions
Ctrl+S / Ctrl+Shift+S	Save / Save as
Ctrl+O	Open
Ctrl+P	Print
Ctrl+F	Find
Ctrl+H	Find and replace
Ctrl+U (outside text)	Insert a unit
F9	Recalculate
Ctrl+= / Ctrl+- / Ctrl+0	Zoom in / out / actual size
Ctrl + mouse wheel	Zoom
Right-click a region	Commands for that region (edit, collapse, note, line format)
Ctrl+Enter / Esc (in a program)	Finish / cancel editing the program

Keys	Action
Tab (in a program)	Indent (Python blocks too)
Ctrl+C / Ctrl+V (several regions selected)	Copy and paste them with their layout, also into another tab
Enter (area selected)	Collapse or expand the area
→ / ← / Esc (presentation)	Next step / previous step / exit
Esc (Match properties)	Stop matching
P B M E L A R O F T I (drawing board)	Pencil, brush, marker, eraser, line, arrow, rectangle, ellipse, fill, text, colour picker
[and] (drawing board)	Smaller / bigger
Drag a window's title bar	Move the window

CHAPTER 22

Troubleshooting

Message or problem	What it means and how to fix it
Undefined symbol x	x is used before it is defined. Define it higher up, or to the left on the same row. Check the spelling, including capitals.
Undefined function f	Define the function first: $f(x) := \dots$
Units do not match	You added, compared or converted quantities of different kinds, such as km and h. Check the units of each term.
This result has no units, so it cannot be shown in ...	You asked for a unit after $=$ but the answer is a plain number. Remove the unit.
integrate: both limits need the same units	Write 0 m instead of 0 when the other limit is a length.
Endless loop: a function calls itself, or two functions call each other	A definition refers to itself, perhaps through another function: for example $J(x)$ uses $g(x)$ and $g(x)$ uses $J(x)$. Often one name is a typing slip (g instead of h). Check the names inside each definition.
... is a variable on this sheet, so it is not read as a unit here	A variable has the same name as a unit (for example m or s) and is used where it is not straight after a number. Write the unit after a number (3 m), or rename the variable, e.g. m_1 .
I clicked a line and it did not open	One click selects a region (so it can be dragged); double-click it, or press Enter, to edit it.
The numbering of a list restarts at 1	Place the bullets between numbered items in the same text block: numbering then carries on. Or type the number you want, e.g. 3. and a space.
A new tab shows an empty sheet	Another Equation Pad tab is open, so this tab starts fresh and keeps its own draft. Your work is still in the first tab.
There is grey text down the right margin of my PDF	That is the beta note. It is printed only in the margin and is not shown while you work.
A Python program says a block is missing its end	Check the indentation: every line of a block must be indented the same, with spaces or tabs used the same way.
A .xlsx file cannot be read	The first worksheet is read as values. Very old .xls files are not supported: save as .xlsx or .csv first.
No solution found near this guess	Try another guess, or give a range in which the function changes sign: $\text{root}(f(x), x, a, b)$. Plot the function to see where it crosses zero.
root: $f(a)$ and $f(b)$ must have opposite signs	The curve does not cross zero between the two ends. Widen or move the range.
solve: give one unknown for each equation	A system needs as many unknowns, and as many guesses, as equations.
Line 4: a block is missing its “end”	In a program, every if, for and while needs a matching end. The message names the line.
The program ran more than 2 million steps	A loop never finishes: check that the while condition eventually becomes FALSE.
Something I wrote has disappeared	It may be inside a closed area (click ► to open it), or you may be in a presentation (press Esc).
Sizes do not match	Matrices of the wrong sizes were added or multiplied. Use $\text{size}(A) =$ to check.

Message or problem	What it means and how to fix it
In [...], the blocks side by side need the same number of rows	When joining with a comma, every block needs the same number of rows. With a semicolon, the same number of columns.
Syntax error	A bracket or operator is missing. Double-click the line to see the typed text and correct it.
#ERR in a spreadsheet cell	Point at the cell to see the message. Often a formula refers to an empty or text cell.
Spreadsheet T1 must be higher up the sheet	A line reads a spreadsheet that is below it. Move the spreadsheet up or the line down.
A deleted variable still seems to be used	Make sure Calculate ► Calculate automatically is ticked, or press F9. Lines that used a deleted variable then show “Undefined symbol”.
“40×40 matrix” instead of the numbers	The matrix is larger than the display limit. Raise it in Format ► Result format, or show part of it, e.g. $K[1:6, 1:6] =$.
A toolbar has disappeared	View ► Toolbars, or right-click the menu bar. Reset toolbar layout puts them all back.
A matrix or spreadsheet is too wide for the sheet	Select it and drag the blue corner square to the left to make it smaller.
The grid does not print	Check Page setup ► “Print and export the grid”.
Google Drive (or OneDrive) is not available yet	Cloud saving has not been switched on for the copy you are using. Use File ► Save and keep the file in your cloud folder.
The sign-in window does not appear	The browser blocked the pop-up. Allow pop-ups for equationpad.com and try again.
The help assistant does not understand my question	Use a few plain words, such as “page numbers” or “solve equation”, or pick one of the suggested topics. The full guide is in Help ► User guide.
The app shows “only runs at equationpad.com”	The app was opened from a downloaded copy. Open www.equationpad.com instead; your .eqnpad files open there.

APPENDIX A

Function reference

Every function can be used in maths lines and in spreadsheet formulas.

Group	Functions
Arithmetic	abs, add, ceil, cbrt, cube, divide, exp, expm1, fix, floor, gcd, hypot, lcm, log, log10, log1p, log2, mod, multiply, nthRoot, pow, round, sign, sqrt, square, subtract
Trigonometry	sin, cos, tan, sec, csc, cot, asin, acos, atan, atan2, asec, acsc, acot, sinh, cosh, tanh, asinh, acosh, atanh
Statistics	max, min, sum, prod, mean, median, mode, std, variance, mad, quantileSeq, cumsum
Probability	factorial, combinations, permutations, gamma, random, randomInt
Matrices	concat, cross, det, diag, dot, eigs, flatten, identity, inv, kron, lusolve, lup, norm, ones, pinv, qr, range, reshape, resize, size, sort, sqrtm, expm, subset, trace, transpose, zeros
Logic and comparison	and, or, not, xor, equal, unequal, larger, smaller, largerEq, smallerEq, compare, isNaN, isZero, isPositive, isNegative
Units	to (convert), number (strip units, e.g. number(d, km)), unit
Equation Pad	integrate(f, x, a, b), diff(f, x[, a]), summation(f, i, a, b), interp(x, X, Y), root(f, x, guess) or root(f, x, a, b), solve(eq, x, guess), solve([eq1, eq2], [x, y], [g1, g2]), simplify(f), expand(f), ode(rate, t, y, t0, y0, t1[, steps]), plot(f, x, a, b), plot(X, Y)
Spreadsheet formulas	More than a hundred: SUM, SUMIF, SUMIFS, SUMPRODUCT, PRODUCT, ROUND, ROUNDUP, ROUNDDOWN, MROUND, CEILING, FLOOR, INT, ABS, SQRT, POWER, MOD, PI, EXP, LN, LOG, AVERAGE, AVERAGEIF(S), MEDIAN, MODE, MIN, MAX, MINIFS, MAXIFS, COUNT, COUNTA, COUNTBLANK, COUNTIF(S), STDEV, VAR, LARGE, SMALL, RANK, PERCENTILE, IF, IFS, IFERROR, AND, OR, XOR, NOT, SWITCH, CHOOSE, VLOOKUP, HLOOKUP, XLOOKUP, INDEX, MATCH, ROW, COLUMN, CONCAT, TEXTJOIN, LEFT, RIGHT, MID, LEN, UPPER, LOWER, PROPER, TRIM, SUBSTITUTE, FIND, SEARCH, TEXT, VALUE, REPT, TODAY, NOW, DATE, YEAR, MONTH, DAY, WEEKDAY, DAYS, EDATE, ISBLANK, ISNUMBER, ISTEXT, ISERROR, NA, PMT, FV, PV, NPV and more (see Functions in the spreadsheet editor), as well as every function above.

APPENDIX B

Unit reference

The full list, with search and the value of each unit in SI, is in [Insert ► Unit](#). The most common symbols are below. Units marked * in the app accept SI prefixes (p, n, u, m, c, d, k, M, G, T).

Quantity	Units
Length	m *, inch, ft, yd, mi, nmi, mil, thou, micron, fathom, furlong, chain, angstrom
Area	m ² , ha, acre, sqin, sqft, sqyd, sqmi, sqmm, sqcm, sqm, sqkm
Volume	L * (litre), m ³ , cc, gal, usgal, impgal, qt, pt, cup, floz, bbl, cft, cuin, cuyd, acft
Mass	g *, t (tonne), lb / lbm, oz, ton, longton, shortton, slug, carat, grain, stone
Time	s *, min, h, day, week, month, year
Speed, flow	m/s, km/h, kph, mph, knot, fps, fpm · L/s, lps, lpm, m3h, cumec, cfs, cfm, gpm, mgd
Force	N *, kgf, tf, lbf, kip, kipf, ozf, pdl, dyn, tonf
Pressure	Pa *, bar, atm, psi, ksi, psf, ksf, torr, mmHg, inHg, mH ₂ O, inH ₂ O
Energy, power	J *, Wh, kWh, MWh, cal, kcal, BTU, therm, eV, erg · W *, hp, PS, BTUh, TR, VA, VAR
Electrical	A *, V *, ohm *, C *, F *, H *, S *, Wb *, T *
Temperature	K *, degC, degF, degR
Angle, rotation	rad, deg, grad, gon, rev, cycle, arcmin, arcsec, rpm, rps, Hz *
Other	mol *, cd *, bit, byte, pct (per cent), permil

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