Calculator Training - Casio FX-991DE X

Mastering Your Calculator for Sections 1-5

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Introduction

Welcome to Calculator Training!

Your Casio FX-991DE X is a powerful tool

- Today we'll learn how to use it efficiently for the topics in Sections 1-5
- The calculator can verify your manual work and speed up calculations

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> ⓘ Note
>
> This session is organized into 5 parts matching the course sections you've completed.

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> ⚠ Warning
>
> Important: Exams often require you to show your work, so use the calculator to check, not replace understanding

Session Structure

Part	Section	Topics
1	Mathematical Foundations	Fractions, powers, roots, logarithms
2	Equations	Polynomial solver, systems of equations
3	Functions	f(x)/g(x), value tables
4	Advanced Functions	Exponential, trigonometric
5	Differential Calculus	Derivatives

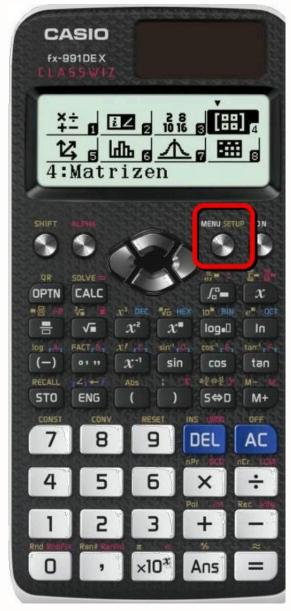### Getting to Know Your Calculator

The MENU Screen

Figure 1: MENU screen showing available applications

- Press MENU to see all applications
- Use arrow keys to navigate the icon grid, press number or = to select
- 1: Berechnungen (Calculate) is your main mode

Essential Settings

Before we begin, let's configure the calculator:

1. Press SHIFT MENU (Setup)
2. Select 1: Eingabe/Ausgabe → 1: Math –> Math for natural display
3. Select 2: Winkeleinheit → 1: Gradmaß (D) for degrees

Figure 2: Settings menu

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> 💡 **Tip**
>
> The natural display mode shows fractions and roots as you write them on paper!

Menu Navigation

Figure 3: Keyboard layout with key functions

- Use SHIFT + template keys for calculus (d/dx, Σ, Π)
- Press MENU then navigate with arrow keys or press A for Gleichung/Funkt
- CALC button for evaluating expressions with variables

Part 1: Mathematical Foundations

Connecting to Section 01

In Section 01, you learned:

- Number systems and set theory
- Order of operations and exponents
- Advanced factorization and radicals
- Logarithms and algebraic substitution

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Now let's see how your calculator handles these!

Entering Fractions

Two ways to enter fractions:

Mixed fraction: $3\frac{1}{2}$

- Press SHIFT + fraction key (for mixed fraction template)
- Enter: `3 → 1 → 2`

Improper fraction: $\frac{7}{2}$

- Press fraction key
- Enter: `7 → 2`

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> 💡 Tip
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> Use the arrow keys to move between numerator and denominator fields.

Fraction Calculations

Example: Calculate $\frac{2}{3} + 1\frac{1}{2}$

. . .

Figure 4: Fraction calculation example

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Result: $\frac{13}{6}$

. . .

To convert between improper and mixed fractions:

. . .

- Press S <-> D for conversion

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> ℹ Note
>
> So far, nothing is really new, right?

Calculation History

A time-saving feature:

- Press ↑ (up arrow) to recall your previous calculation
- Edit the expression and press = to recalculate
- Navigate through multiple previous calculations with ↑ and ↓

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> 💡 Tip
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> This is very useful when you made a small mistake or want to try different values!

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> ⚠ Warning
>
> This only works as long as you don't click the ON button, change the computation mode, or reset the data!

Percentage Calculations

Using the percent function:

Press SHIFT then ANS to access percentage calculations.

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Example: What is 15% of 240?

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Enter: `240 × 15 SHIFT ANS =`

. . .

Result: 36

. . .

Example: Increase 200 by 8%

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Enter: `200 + 200 × 8 SHIFT ANS =`

. . .

Result: 216

. . .

> 💡 Tip
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> You can always just use 0.08 for 8% as well!

Powers and Roots

Powers and roots can also be easily computed using a calculator:

. . .

Example 1: Calculate $5^3 + \sqrt[4]{16}$

. . .

Enter: `5 ^ 3 + SHIFT x^ 4 → 16 =`

. . .

Result: 127

. . .

Example 2: Calculate $\left(2^3 + \sqrt[3]{27}\right) \times \sqrt[5]{32}$

. . .

Enter: `( 2 ^ 3 + SHIFT x^ 3 → 27 ) × SHIFT x^ 5 → 32 =`

. . .

Result: 128

Scientific Notation

For very large or small numbers:

Use the ×10ˣ button to enter scientific notation.

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Example 1: Enter 6.022×10^{23}

. . .

Enter: `6.022 10ˣ 23 =`

. . .

Example 2: Calculate $\frac{1.5 \times 10^8}{3 \times 10^4}$

. . .

Enter: `1.5 10ˣ 8 ÷ 3 10ˣ 4 =`

. . .

Result: $5 \times 10^3 = 5000$

Logarithms

Your calculator handles all three logarithm types:

Function	Access
$\log_{10}(x)$	SHIFT + (-) button
$\ln(x)$	ln button
$\log_a(b)$	log (log button)

. . .

Example: Calculate $\log_2(32)$

. . .

Enter: `log 2 → 32 =`

. . .

Result: 5 (because $2^5 = 32$)

Memory Variables

Store values for repeated use:

- Variables available: A, B, C, D, E, F, x, y, M
- Store: Enter value, press STO, then variable letter (no shift/alpha)
- Recall: Press ALPHA + variable letter

. . .

Example: Store 3.14159 in A

- Enter `3.14159 → STO → A`
- Use later: `2 × ALPHA A =` gives 6.28318

. . .

> 💡 Tip
>
> Ans automatically stores your last result!

The Ans Button

Using your last result efficiently:

The Ans button recalls your last calculation result.

- Ans is automatically inserted when you start with an operator

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Example: Calculate $5 + 3$, then multiply by 2:

...

- Enter: `5 + 3 =` → Result: 8
- Enter: `× 2 =` → Calculator shows `Ans × 2 = 16`

...

> 💡 Tip
>
> Chain calculations become much faster with Ans!

The CALC Button

Evaluate expressions with different values:

The CALC button lets you enter an expression with variables.

1. Enter an expression with variables (e.g., `3A + B`)
2. Press CALC
3. Enter values when prompted (A = ?, B = ?)
4. Press = to see the result

...

Example: Evaluate $3A + B$ for $A = 5$, $B = 10$

...

- Enter: `3 ALPHA A + ALPHA B` → CALC → `5 = 10 =`
- Result: 25

Prime Factorization (FACT)

Factor integers into prime factors:

1. Enter a positive integer and press =
2. Press SHIFT + FACT

...

Example: Find the prime factorization of 84

...

- Enter: `84 =` then SHIFT + FACT
- Result: $2^2 \times 3 \times 7$

...

> ℹ️ Note
>
> Works for integers up to 10 digits. Useful for simplifying fractions!

GCD and LCM

Greatest Common Divisor and Least Common Multiple:

Access GCD and LCM functions via ALPHA + * or ALPHA + /.

Function	Syntax	Example
GCD	GCD(a; b)	GCD(24; 36) = 12
LCM	LCM(a; b)	LCM(24; 36) = 72

. . .

Example: Find GCD(48, 180)

. . .

- Enter: `ALPHA` + * then `GCD(48; 180) =`
- Result: 12

. . .

> 💡 Tip
>
> Useful for simplifying fractions: $\frac{48}{180} = \frac{48 \div 12}{180 \div 12} = \frac{4}{15}$

Practice: Part 1

Try these on your calculator:

1. Calculate: $\frac{5}{8} + \frac{3}{4} - \frac{1}{2}$
2. Evaluate: $\sqrt{144} + 3^4 - 2^5$
3. Find: $\log(1000) + \ln(e^2)$
4. Verify: $\log_3(81) = 4$
5. Find the prime factorization of 360
6. Calculate GCD(72, 120) and LCM(72, 120)
7. Use CALC to evaluate $2x^2 + 3x - 5$ for $x = 4$

Part 2: Equations & Problem-Solving

Connecting to Section 02

In Section 02, you learned to solve:

- Linear equations and word problems
- Systems of linear equations
- Quadratic and biquadratic equations
- Fractional, radical, and cubic equations

. . .

The calculator has powerful equation-solving modes!

Accessing the Equation Solver

From MENU:

1. Press MENU → A (Gleichung/Funkt)
2. Choose your equation type:
   - 1: Gleichungssyst. = Systems of linear equations
   - 2: Polynom-Gleich. = Polynomial equations

Solving Quadratic Equations

Solve $x^2 + 2x - 2 = 0$

1. Press MENU → A → 2 (Polynom-Gleich.)
2. Select Grad: 2
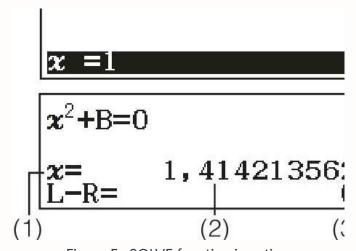3. Enter coefficients: a = 1, b = 2, c = –2
4. Press = to see solutions

Figure 5: SOLVE function in action

Interpreting Polynomial Solutions

The calculator shows:

- $x_1 = -1 + \sqrt{3}$
- $x_2 = -1 - \sqrt{3}$

Press = repeatedly to cycle through all solutions.

. . .

> 💡 Tip
>
> After the two x-values, it also shows you the vertex!

Solving Systems of Equations

Solve the system:

$$\begin{cases} x - y + z = 2 \\ x + y - z = 0 \\ -x + y + z = 4 \end{cases}$$

1. Press MENU → A → 1 → 3 Unbekannte
2. Enter coefficients in matrix form!
3. Press = for solution: $x = 1, y = 1, z = 2$

2×2 Systems: Market Equilibrium

From Section 02: Find equilibrium where supply equals demand

$$Q_d = 100 - 2P \quad \text{(Demand)}$$
$$Q_s = 20 + 3P \quad \text{(Supply)}$$

. . .

Rewrite as system:

$$\begin{cases} Q + 2P = 100 \\ Q - 3P = 20 \end{cases}$$

. . .

Calculator solution: $P = 16, Q = 68$

The SOLVE Function I

Newton's method for solving any equation:

SOLVE (accessed via SHIFT + CALC) uses Newton's approximation method to find solutions.

. . .

1. Enter an equation (e.g., `x² + B = 0`)
2. Press SHIFT + CALC (SOLVE)
3. Enter an initial guess for x and values for other variables
4. Press = to find the solution

The SOLVE Function II

Newton's method for solving any equation:

Example: Solve $x^2 - 2 = 0$ (find $\sqrt{2}$)

- Enter: `ALPHA x² - 2` → SHIFT CALC → initial guess: `1 =`
- Result: $x = 1.414213562$ (which is $\sqrt{2}$)

. . .

> ⚠️ **Warning**
>
> SOLVE uses numerical methods, so:
>
> - Results depend on your initial guess
> - Multiple solutions require different starting points
> - The closer your guess, the faster and more reliable the result

Practice: Part 2

Try these equation problems:

1. Solve: $x^2 - 5x + 6 = 0$

2. Solve: $2x^2 + 3x - 5 = 0$

3. Solve the system:

$$\{3x + 2y = 18$$
$$x - y = 1$$

4. Find break-even: $P(x) = -x^2 + 10x - 16 = 0$

5. Use SOLVE to find where $x^3 - 5x + 3 = 0$ (start with $x = 1$)

Break - 10 Minutes

Part 3: Functions as Business Models

Connecting to Section 03

In Section 03, you learned:

- Function concepts and notation $f(x)$
- Linear functions and break-even analysis
- Quadratic functions and optimization
- Function transformations

. . .

Your calculator can store and evaluate function definitions!

Defining f(x) and g(x)

Register a function for repeated use:

1. Press MENU → 9 (Tabellen)
2. Enter your function expression for $f(x)$
3. You can also define a second function $g(x)$
4. Press = to continue to table settings

...

Evaluating Functions

Once f(x) is defined in Tabellen mode:

The calculator generates a table showing function values:

- Set Start, Ende, and Inkre to define x-values
- The table displays both x and f(x) values

...

Example: $f(x) = x^2 - 4x + 3$

- Try to compute f(x) from x=0 to x=3 with step 1
- What can you see?

...

ℹ Note

This helps verify zeros and critical points!

Composite Functions

Evaluating composite functions step-by-step:

...

For $f(g(x))$, work from inside out:

1. First calculate $g(x)$ at your value
2. Then use that result in $f(x)$

...

Example: $f(x) = 2x + 1$, $g(x) = x^2$

...

- To find $f(g(3))$:
- $g(3) = 3^2 = 9$
- $f(9) = 2(9) + 1 = 19$

Practice: Part 3

Try these function exercises:

1. Define $f(x) = 3x^2 - 12x + 9$ and find $f(0)$, $f(1)$, $f(2)$, $f(3)$

2. For $f(x) = x + 2$ and $g(x) = x^2$, calculate $f(g(2))$ and $g(f(2))$

3. Create a table for $f(x) = -x^2 + 4x$ from $x = 0$ to $x = 4$

Part 4: Advanced Functions

Connecting to Section 04

In Section 04, you learned:

- Polynomial and power functions
- Exponential functions and growth/decay
- Trigonometric functions
- Rational and logarithmic functions

. . .

This section is shorter, as many concepts require understanding, not just calculation.

Exponential Calculations

Key buttons for exponential functions:

Operation	Keys
e^x	SHIFT + ln
10^x	SHIFT + log
x^n	Use x^ key

. . .

Examples:

- $e^2 = 7.389...$
- $10^{1.5} = 31.62...$
- $2^{10} = 1024$

Trigonometric Functions

Make sure angle mode is set correctly!

Check indicator: D = Degrees, R = Radians

Function	Keys
$\sin(x)$	sin
$\cos(x)$	cos
$\tan(x)$	tan
$\sin^{-1}(x)$	SHIFT + sin

. . .

Example: $\sin(30°) = 0.5$

Practice: Part 4

Try these calculations:

1. Calculate: e^3 and e^{-1}

2. Find: $\sin(45°), \cos(60°), \tan(30°)$

3. What angle has $\sin(\theta) = 0.5$?

4. Convert $45°$ to radians

Coffee Break - 15 Minutes

Part 5: Differential Calculus

Connecting to Section 05

In Section 05, you learned:

- Limits and continuity
- The derivative as rate of change
- Differentiation rules
- Optimization and curve sketching

. . .

This is the most important calculator section, numerical derivatives!

Accessing Calculus Functions

Access via template keys:

In Math mode, calculus templates are available via SHIFT + specific keys:

Function	Access
Derivative	SHIFT + ∫ (d/dx template)
Summation	SHIFT + x (Σ template)
Product	ALPHA + x (Π template)

. . .

> 💡 Tip
>
> This can sometimes be really helpful!

Numerical Derivatives

Syntax: $\frac{d}{dx}(f(x))\big|_{x=a}$

The calculator computes the derivative at a specific point.

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Example: Find $f'(\frac{\pi}{2})$ for $f(x) = \sin(x)$

- Enter: SHIFT + ∫ (d/dx) → enter `sin(x)` → set x = π/2 → press =
- Result: 0 (as expected, since $\cos(\frac{\pi}{2}) = 0$)

. . .

Let's try this together with the proper function.

Using Derivatives: Step by Step

To find $f'(2)$ for $f(x) = x^3 - 3x^2 + 2$:

. . .

1. Press SHIFT + ∫ to access the d/dx template
2. The template appears: $\frac{d}{dx}(\square)\big|_{x=\square}$
3. Enter the function: `x^3 - 3x^2 + 2`
4. Move cursor to x-value field, enter 2
5. Press =

. . .

Result: $f'(2) = 0$

. . .

> 💡 Tip
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> This confirms $x = 2$ is a critical point!

Verifying Critical Points

Use derivatives to check if $f'(c) = 0$:

Example: For $f(x) = x^3 - 6x^2 + 9x$

. . .

Point	$f'(x)$ value	Interpretation
$x = 1$	0	Critical point!
$x = 2$	–3	Decreasing
$x = 3$	0	Critical point!

. . .

> 💡 Tip
>
> $f'(c) = 0$ means critical point, but check second derivative or sign changes for max/min!

...

> ⚠️ Warning
>
> It cannot determine the derivative function for you. It only computes specific values!

Practice: Part 5

Essential derivative exercises:

1. For $f(x) = x^2 - 4x + 3$, find $f'(0)$, $f'(2)$, $f'(4)$

2. Verify that $x = 2$ is a critical point of $f(x) = x^2 - 4x + 5$

3. For $f(x) = x^3 - 3x$, find where $f'(x) = 0$

4. For $R(t) = 100t - 2t^2$ (revenue over time), find:
   - Rate of change at $t = 10$
   - When is revenue maximized?

5. $C(x) = 500 + 20x + 0.1x^2$ is a cost function, find marginal cost at $x = 50$

Wrap-up

Quick Reference

Problem Type	Calculator Mode/Function
Quadratic/cubic equations	MENU → A → 2 (Polynom-Gleich.)
Systems of equations	MENU → A → 1 (Gleichungssyst.)
Numerical equation solving	SHIFT + CALC (SOLVE)
Evaluate with variables	CALC button
Value tables	MENU → 9 (Tabellen)
Derivatives at a point	SHIFT + ∫ (d/dx template)
Prime factorization	SHIFT + FORMAT → Primfakt.
GCD/LCM	Function menu (GCD, LCM)

Common Mistakes to Avoid

Try to avoid the following if possible.

1. Wrong angle mode - Check D/R indicator before trig calculations
2. Forgetting parentheses - Use them liberally: $\sin(30)$ not $\sin 30$
3. Not closing brackets - Natural display helps avoid this
4. Division issues - Use parentheses: $(a + b)/(c + d)$
5. Relying only on calculator - Understand why the answer is correct

Calculator vs. When to Show Work

Calculator is useful for:

- Verifying your manual calculations
- Complex arithmetic
- Solving equations to check your work

. . .

Exams typically require you to show:

- Differentiation steps (product rule, chain rule, etc.)
- Setting up equations from word problems
- Algebraic manipulation
- Interpretation of results

Final Integrated Exercise

Combine everything you've learned today:

A company's profit function is $P(x) = -0.5x^2 + 30x - 200$

Using your calculator:

a) Find the break-even points (where $P(x) = 0$)

b) Find the production level that maximizes profit (where $P'(x) = 0$)

c) Calculate the maximum profit $P(x_{max})$

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> $\mathbf{i}$ Note
>
> Complete the Calculator Training Tasks 01 worksheet to reinforce these skills!

Thank You!