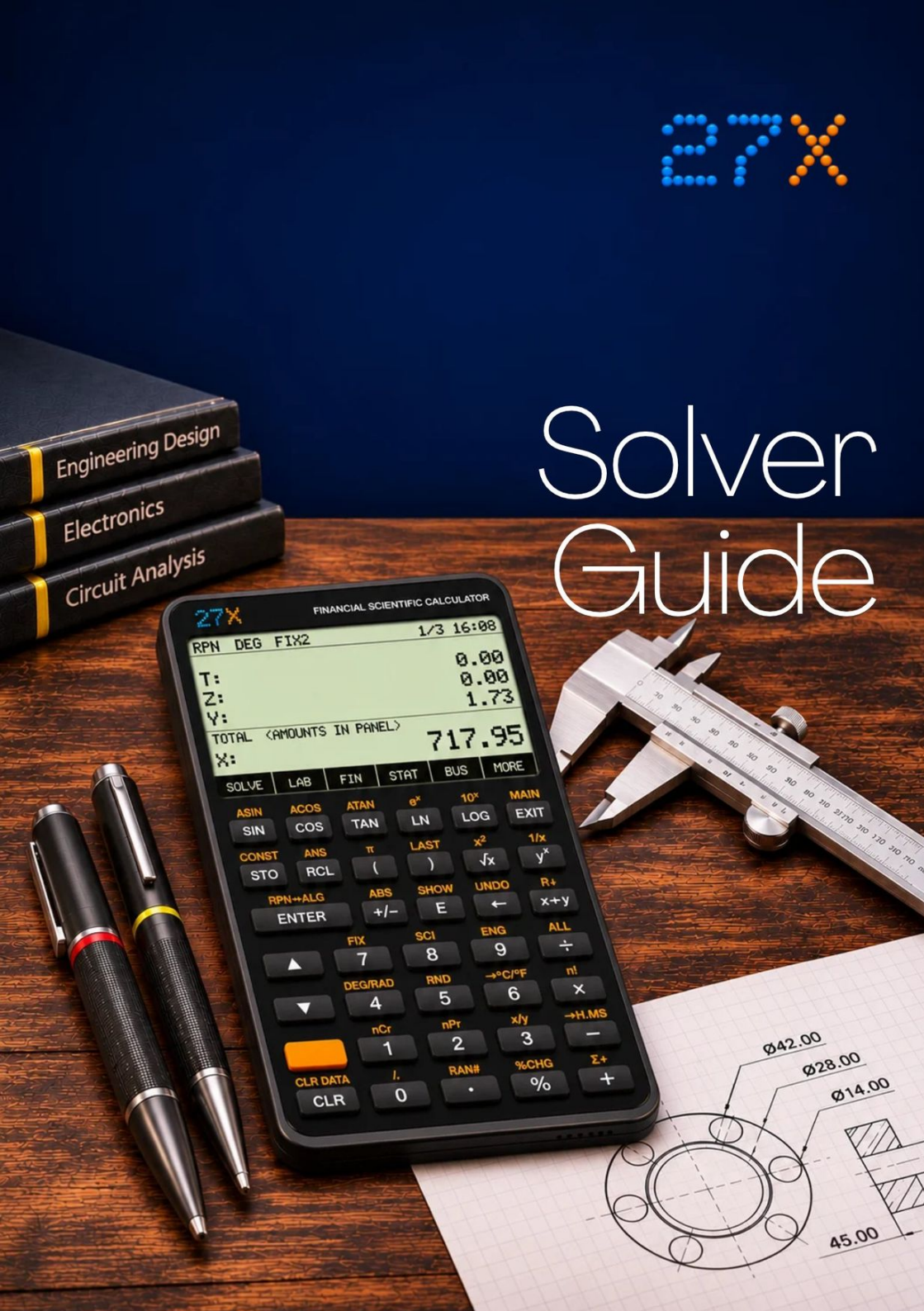
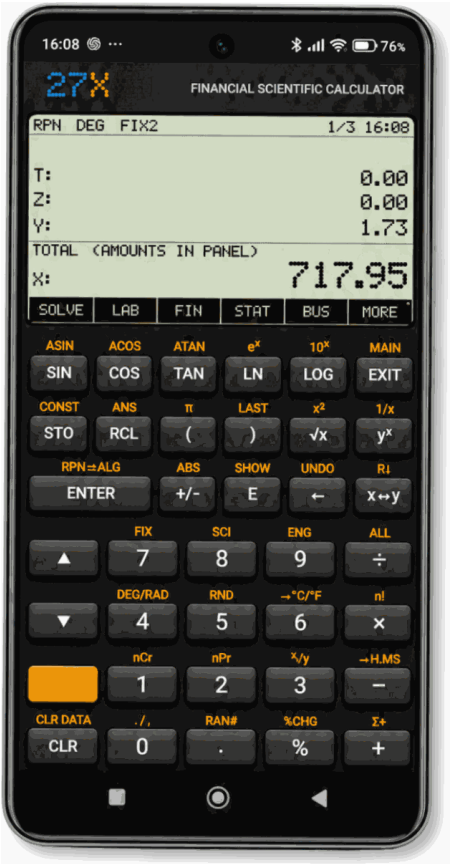

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Electronics
Circuit Analysis
27X
FINANCIAL SCIENTIFIC CALCULATOR
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CalcCraft

Financial Scientific Calculator

Solver Guide · edition 1



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About this guide

The solver turns any equation into a menu: every name becomes a soft key, you type the values you know, and tap the key of the one you want. This guide is a collection of ready-to-use equations from four fields, each worked through on the CalcCraft 27X. Every example was run on the calculator and its answer checked against an independent calculation.

The equations are standard formulas, the kind found in textbooks and in the application books that came with the classic solver calculators. The stories and numbers are our own.

This is edition 1 of the Solver Guide. It works with CalcCraft 27X 0.7.2 and every later version: the solver does not change from release to release, so this guide keeps its own edition number and is only revised when the guide itself changes. The screens may show a different version number from yours.

How each example is laid out

- **The story**: what is known and what is wanted.
- **The equation**, in a grey box, exactly as you type it, with a suggested name for the equation list.
- **A step table**: the keys to press, what the display shows after each step, and what the step does.
- **The result**, and the calculator screen at the end.
- Many examples then **solve the same equation backwards** for a different unknown, carrying on from the values already stored. That is the solver's real strength: one equation, any unknown.

Entering an equation

1. Tap ‹SOLVE›, then ‹NEW›.
2. Type the equation from the grey box. You can type * and /; they become × and ÷. Parts of IF, Σ and the like are separated with colons.
3. Type the name into the Name box (optional, but it makes the list readable).

4. When the live check shows ✓ Ready, tap **Save**. Then tap ‹CALC› to get the soft keys.

To store a value, type it and tap its soft key. To solve, tap the key of the unknown without typing a number first. Values stay stored, so you only change the ones that differ for the next case.

Good habits

- **Units.** The solver doesn't know about units: keep to one consistent set, as each example states.
- **Display.** Very large or very small answers read best in SCI (orange 8): 7.23E-5 rather than 0.00.
- **Guesses.** When an equation has more than one answer, store a guess near the one you want before solving. The projectile example shows how.
- **Check once.** After saving a new equation, solve it once with numbers whose answer you know.

> The User Guide explains the solver in full: the equation screen, templates, IF, S(), Σ, L() and G(), and what the solver messages mean (Appendix D, More about the solver).

1. Business and finance

Prices and margins, loans and savings, depreciation, stock control and investment decisions. The finance menus already handle standard loans and cash flows; these equations cover the variations they don't, and show how to build your own.

Example	Name
Selling price from a target margin	Price from margin
Break-even volume	Break-even
Simple interest for a number of days	Simple interest
Compound growth rate	Growth rate
Monthly loan repayment	Loan repayment
Adding and removing VAT	VAT
Quantity discount (nested IF)	Quantity discount
Pay with overtime	Weekly pay
Straight-line book value	Book value
Economic order quantity	Order quantity
Growing cash flows: NPV and IRR (Σ)	Growing cash flows
Nominal and effective rates	Effective rate
Doubling time	Doubling time
Saving towards a goal	Savings goal
Profit after commission (L and G)	Profit

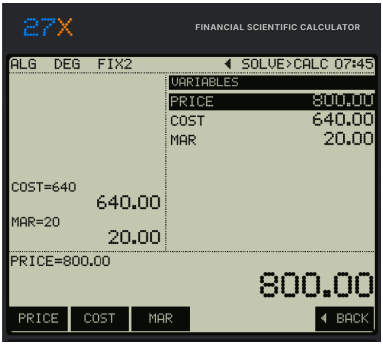
Selling price from a target margin

A product costs 640 to make and must earn a 20% margin on the selling price.

```
PRICE=COST÷(1−MAR÷100)
```
Name: Price from margin

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
640 **‹COST›**	COST=640.00	Stores 640 in COST
20 **‹MAR›**	MAR=20.00	Stores 20 in MAR
‹PRICE›	PRICE=800.00	Calculates PRICE

Result: PRICE = **800.00**



Then: The market will only pay 950. What margin is that?

Keys	Display	What it does
950 **‹PRICE›**	PRICE=950.00	Stores 950 in PRICE
‹MAR›	MAR=32.63	Calculates MAR

Result: MAR = **32.63** %



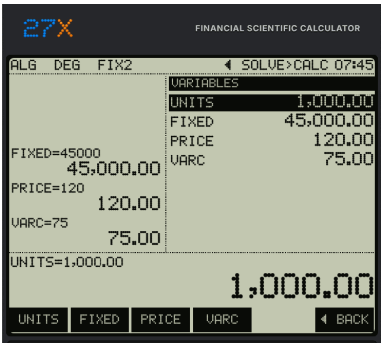
Break-even volume

Fixed costs are 45 000 a month; each unit sells for 120 and costs 75 to make (VARC).

```
UNITS=FIXED÷(PRICE−VARC)
Name: Break-even
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
45000 **‹FIXED›**	FIXED=45,000.00	Stores 45 000 in FIXED
120 **‹PRICE›**	PRICE=120.00	Stores 120 in PRICE
75 **‹VARC›**	VARC=75.00	Stores 75 in VARC
‹UNITS›	UNITS=1,000.00	Calculates UNITS

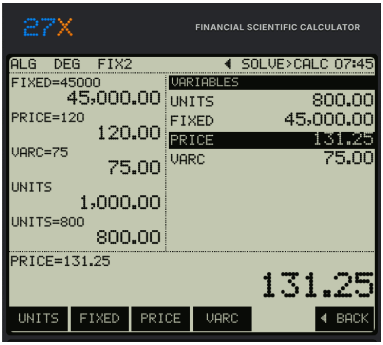
Result: UNITS = **1,000.00** units



Then: What price breaks even at 800 units?

Keys	Display	What it does
800 **‹UNITS›**	UNITS=800.00	Stores 800 in UNITS
‹PRICE›	PRICE=131.25	Calculates PRICE

Result: PRICE = **131.25**



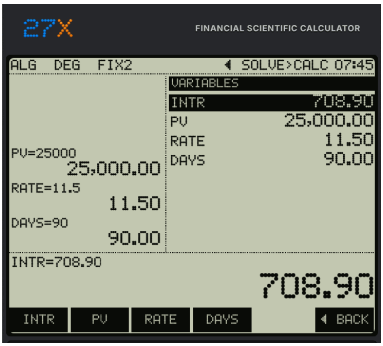
Simple interest for a number of days

25 000 is invested at 11.5% simple interest for 90 days.

```
INTR=PV×RATE÷100×DAYS÷365
```
Name: Simple interest

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
25000 **‹PV›**	PV=25,000.00	Stores 25 000 in PV
11.5 **‹RATE›**	RATE=11.50	Stores 11.5 in RATE
90 **‹DAYS›**	DAYS=90.00	Stores 90 in DAYS
‹INTR›	INTR=708.90	Calculates INTR

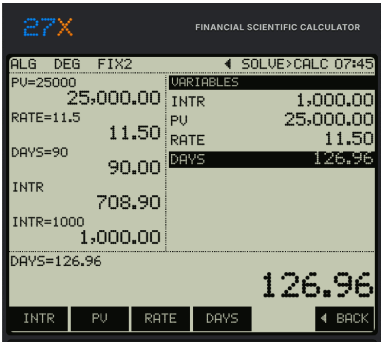
Result: INTR = **708.90**



Then: How many days to earn 1 000?

Keys	Display	What it does
1000 **‹INTR›**	INTR=1,000.00	Stores 1000 in INTR
‹DAYS›	DAYS=126.96	Calculates DAYS

Result: DAYS = **126.96** days



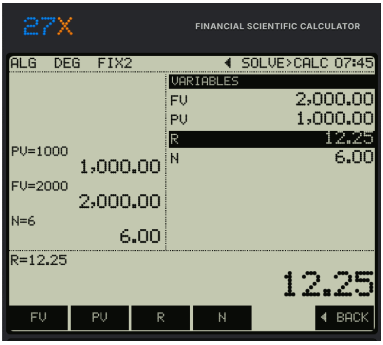
Compound growth rate

An investment of 1 000 grew to 2 000 in 6 years. What was the yearly growth rate?

```
FV=PV×(1+R÷100)^N
Name: Growth rate
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1000 **‹PV›**	PV=1,000.00	Stores 1000 in PV
2000 **‹FV›**	FV=2,000.00	Stores 2000 in FV
6 **‹N›**	N=6.00	Stores 6 in N
‹R›	R=12.25	Calculates R

Result: R = **12.25** % a year



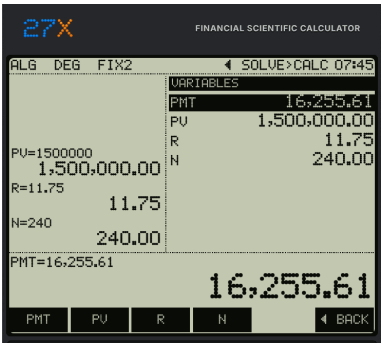
Monthly loan repayment

A home loan of 1 500 000 at 11.75% a year over 240 months.

```
PMT=PV×(R÷1200)÷(1−(1+R÷1200)^−N)
Name: Loan repayment
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1500000 **‹PV›**	PV=1,500,000.00	Stores 1 500 000 in PV
11.75 **‹R›**	R=11.75	Stores 11.75 in R
240 **‹N›**	N=240.00	Stores 240 in N
‹PMT›	PMT=16,255.61	Calculates PMT

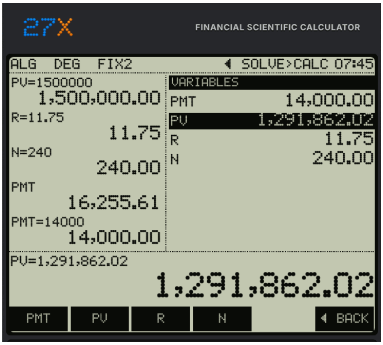
Result: PMT = **16,255.61** a month



Then: How much can be borrowed for 14 000 a month?

Keys	Display	What it does
14000 **‹PMT›**	PMT=14,000.00	Stores 14 000 in PMT
‹PV›	PV=1,291,862.02	Calculates PV

Result: PV = **1,291,862.02**



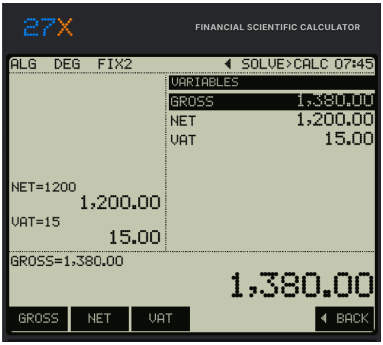
Adding and removing VAT

An invoice of 1 200 before VAT, with VAT at 15%.

```
GROSS=NET×(1+VAT÷100)
Name: VAT
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1200 **‹NET›**	NET=1,200.00	Stores 1200 in NET
15 **‹VAT›**	VAT=15.00	Stores 15 in VAT
‹GROSS›	GROSS=1,380.00	Calculates GROSS

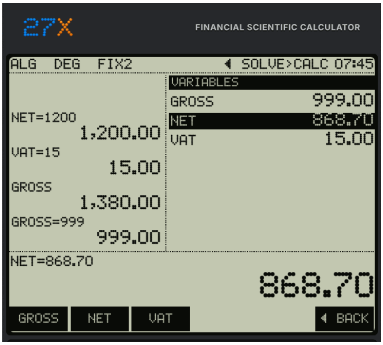
Result: GROSS = **1,380.00**



Then: A price of 999 includes VAT. What is it without?

Keys	Display	What it does
999 **‹GROSS›**	GROSS=999.00	Stores 999 in GROSS
‹NET›	NET=868.70	Calculates NET

Result: NET = **868.70**



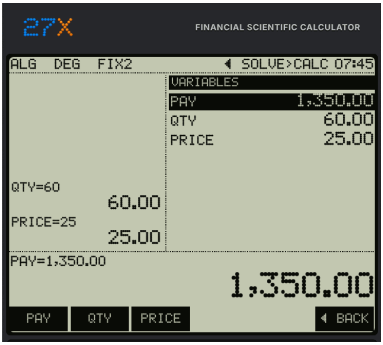
Quantity discount (nested IF)

10% off for 50 or more, 15% off for 100 or more. 60 items at 25 each.

```
PAY=QTY×PRICE×(1−IF(QTY≥100:0.15:IF(QTY≥50:0.1:0)))
```
Name: Quantity discount

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
60 **‹QTY›**	QTY=60.00	Stores 60 in QTY
25 **‹PRICE›**	PRICE=25.00	Stores 25 in PRICE
‹PAY›	PAY=1,350.00	Calculates PAY

Result: PAY = **1,350.00**



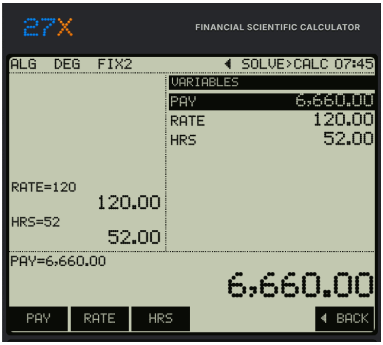
Pay with overtime

Time and a half after 45 hours. 52 hours at 120 an hour.

```
PAY=RATE×MIN(HRS:45)+IF(HRS>45:1.5×RATE×(HRS−45):0)
```
Name: Weekly pay

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
120 **‹RATE›**	RATE=120.00	Stores 120 in RATE
52 **‹HRS›**	HRS=52.00	Stores 52 in HRS
‹PAY›	PAY=6,660.00	Calculates PAY

Result: PAY = **6,660.00**



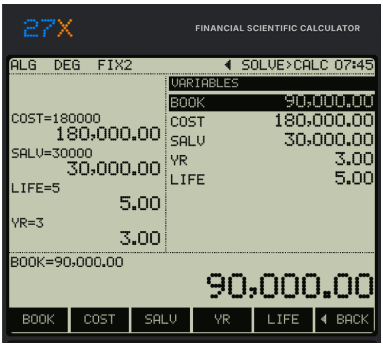
Straight-line book value

A vehicle costs 180 000, will be worth 30 000 after 5 years. Its book value after 3 years:

```
BOOK=COST−(COST−SALV)×YR÷LIFE
Name: Book value
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
180000 **‹COST›**	COST=180,000.00	Stores 180 000 in COST
30000 **‹SALV›**	SALV=30,000.00	Stores 30 000 in SALV
5 **‹LIFE›**	LIFE=5.00	Stores 5 in LIFE
3 **‹YR›**	YR=3.00	Stores 3 in YR
‹BOOK›	BOOK=90,000.00	Calculates BOOK

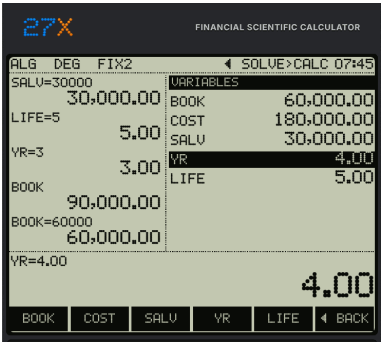
Result: BOOK = **90,000.00**



Then: When does the book value reach 60 000?

Keys	Display	What it does
60000 **‹BOOK›**	BOOK=60,000.00	Stores 60 000 in BOOK
‹YR›	YR=4.00	Calculates YR

Result: YR = **4.00** years



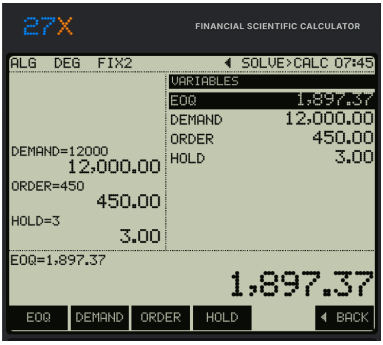
Economic order quantity

12 000 units a year, 450 to place an order, 3 per unit a year to hold stock.

```
EOQ=SQRT(2×DEMAND×ORDER÷HOLD)
Name: Order quantity
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
12000 **‹DEMAND›**	DEMAND=12,000.00	Stores 12 000 in DEMAND
450 **‹ORDER›**	ORDER=450.00	Stores 450 in ORDER
3 **‹HOLD›**	HOLD=3.00	Stores 3 in HOLD
‹EOQ›	EOQ=1,897.37	Calculates EOQ

Result: EOQ = **1,897.37** units



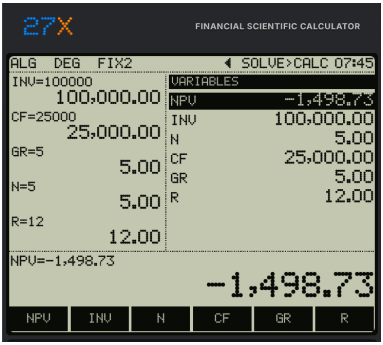
Growing cash flows: NPV and IRR (Σ)

Invest 100 000 for 5 years of income starting at 25 000 and growing 5% a year, at 12%.

```
NPV=−INV+Σ(K:1:N:1:CF×(1+GR÷100)^(K−1)÷(1+R÷100)^K)
```
Name: Growing cash flows

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
100000 **‹INV›**	INV=100,000.00	Stores 100 000 in INV
25000 **‹CF›**	CF=25,000.00	Stores 25 000 in CF
5 **‹GR›**	GR=5.00	Stores 5 in GR
5 **‹N›**	N=5.00	Stores 5 in N
12 **‹R›**	R=12.00	Stores 12 in R
‹NPV›	NPV=-1,498.73	Calculates NPV

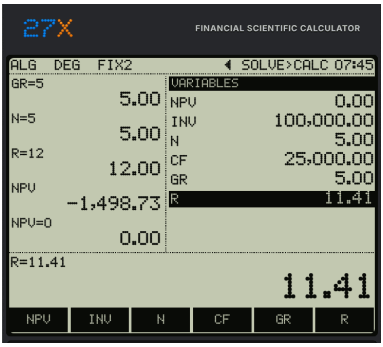
Result: NPV = **-1,498.73**



Then: The IRR is the rate that makes NPV zero:

Keys	Display	What it does
0 **‹NPV›**	NPV=0.00	Stores 0 in NPV
‹R›	R=11.41	Calculates R

Result: R = **11.41** %



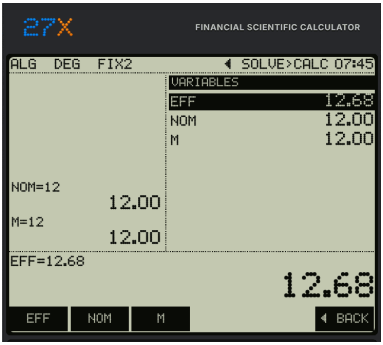
Nominal and effective rates

12% a year compounded monthly (M = 12).

```
EFF=100×((1+NOM÷100÷M)^M−1)
Name: Effective rate
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
12 **‹NOM›**	NOM=12.00	Stores 12 in NOM
12 **‹M›**	M=12.00	Stores 12 in M
‹EFF›	EFF=12.68	Calculates EFF

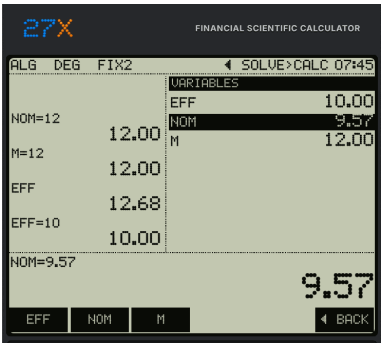
Result: EFF = **12.68** %



Then: What nominal rate gives an effective 10%?

Keys	Display	What it does
10 **‹EFF›**	EFF=10.00	Stores 10 in EFF
‹NOM›	NOM=9.57	Calculates NOM

Result: NOM = **9.57** %



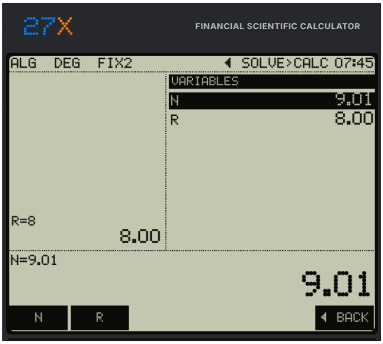
Doubling time

How long does money take to double at 8% a year?

```
N=LN(2)÷LN(1+R÷100)
```
Name: Doubling time

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
8 **‹R›**	R=8.00	Stores 8 in R
‹N›	N=9.01	Calculates N

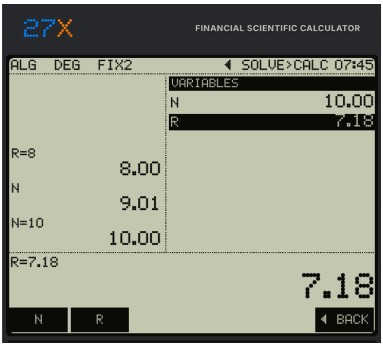
Result: N = **9.01** years



Then: What rate doubles money in 10 years?

Keys	Display	What it does
10 ‹N›	N=10.00	Stores 10 in N
‹R›	R=7.18	Calculates R

Result: R = **7.18** %



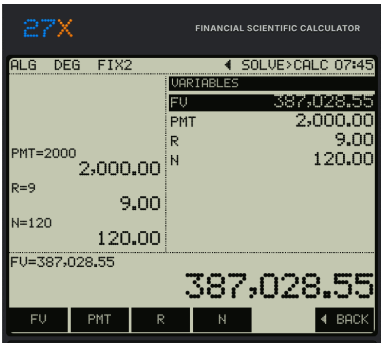
Saving towards a goal

2 000 a month for 10 years (120 months) at 9% a year.

```
FV=PMT×((1+R÷1200)^N−1)÷(R÷1200)
```
Name: Savings goal

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
2000 **‹PMT›**	PMT=2,000.00	Stores 2000 in PMT
9 **‹R›**	R=9.00	Stores 9 in R
120 **‹N›**	N=120.00	Stores 120 in N
‹FV›	FV=387,028.55	Calculates FV

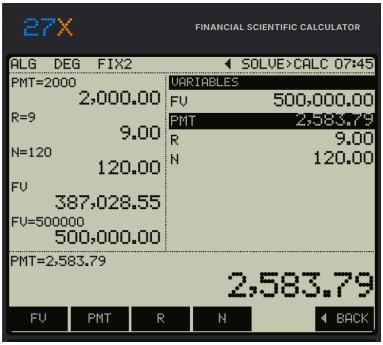
Result: FV = **387,028.55**



Then: What monthly saving reaches 500 000?

Keys	Display	What it does
500000 **‹FV›**	FV=500,000.00	Stores 500 000 in FV
‹PMT›	PMT=2,583.79	Calculates PMT

Result: PMT = **2,583.79** a month



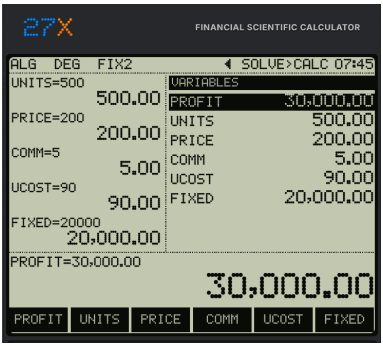
Profit after commission (L and G)

500 units at 200, 5% sales commission, 90 per unit to make, 20 000 fixed. REV is kept with L() and reused with G().

```
PROFIT=L(REV:UNITS×PRICE)−G(REV)×COMM÷100−UNITS×UCOST−
FIXED
```
Name: Profit

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
500 **‹UNITS›**	UNITS=500.00	Stores 500 in UNITS
200 **‹PRICE›**	PRICE=200.00	Stores 200 in PRICE
5 **‹COMM›**	COMM=5.00	Stores 5 in COMM
90 **‹UCOST›**	UCOST=90.00	Stores 90 in UCOST
20000 **‹FIXED›**	FIXED=20,000.00	Stores 20 000 in FIXED
‹PROFIT›	PROFIT=30,000.00	Calculates PROFIT

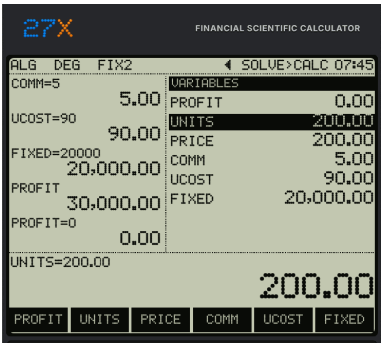
Result: PROFIT = **30,000.00**



Then: How many units break even (PROFIT = 0)?

Keys	Display	What it does
0 **‹PROFIT›**	PROFIT=0.00	Stores 0 in PROFIT
‹UNITS›	UNITS=200.00	Calculates UNITS

Result: UNITS = **200.00** units



2. Laboratory, chemistry and formulation

Dilutions, concentrations, gases, pH and buffers, reaction rates and batch work. Amounts are in the units given in each example: keep to one consistent set.

Example	Name
Dilution: C1·V1 = C2·V2	Dilution
Mass for a molar solution	Molar mass
Ideal gas law	Ideal gas
pH and hydrogen-ion concentration	pH
Buffer: Henderson–Hasselbalch	Buffer pH
Adding an active to a fixed % of the final product	Active addition
Mixing two strengths	Mixing
Beer–Lambert absorbance	Absorbance
Half-life decay	Decay
Rate constant at another temperature (Arrhenius)	Arrhenius
Temperature scales in one equation (S)	Temperatures
% w/v to molarity	Percent to molar
Gas density	Gas density
Titration	Titration
Cooling time (Newton's law)	Cooling

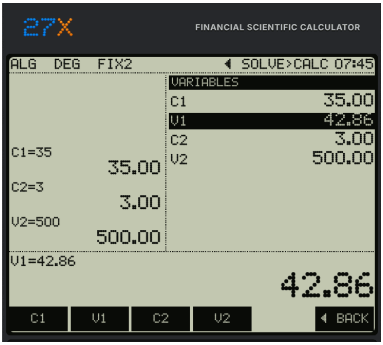
Dilution: C1·V1 = C2·V2

Make 500 mL of 3% hydrogen peroxide from 35% stock.

```
C1×V1=C2×V2
Name: Dilution
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
35 **‹C1›**	C1=35.00	Stores 35 in C1
3 **‹C2›**	C2=3.00	Stores 3 in C2
500 **‹V2›**	V2=500.00	Stores 500 in V2
‹V1›	V1=42.86	Calculates V1

Result: V1 = **42.86** mL of stock



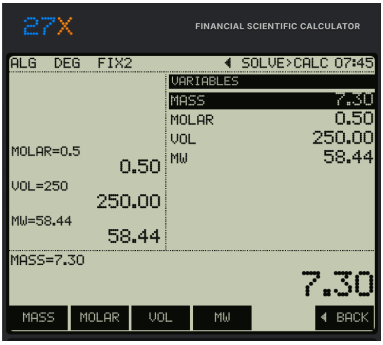
Mass for a molar solution

250 mL of 0.5 M sodium chloride (MW 58.44 g/mol).

```
MASS=MOLAR×VOL÷1000×MW
```
Name: Molar mass

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
0.5 **‹MOLAR›**	MOLAR=0.50	Stores 0.5 in MOLAR
250 **‹VOL›**	VOL=250.00	Stores 250 in VOL
58.44 **‹MW›**	MW=58.44	Stores 58.44 in MW
‹MASS›	MASS=7.30	Calculates MASS

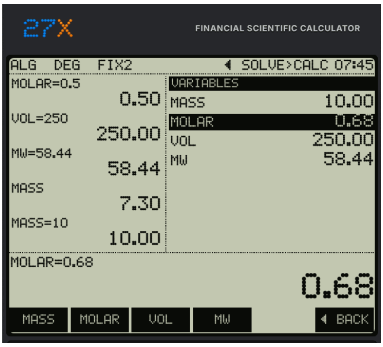
Result: MASS = **7.30** g



Then: 10 g was weighed instead. What molarity is it?

Keys	Display	What it does
10 **‹MASS›**	MASS=10.00	Stores 10 in MASS
‹MOLAR›	MOLAR=0.68	Calculates MOLAR

Result: MOLAR = **0.68** M



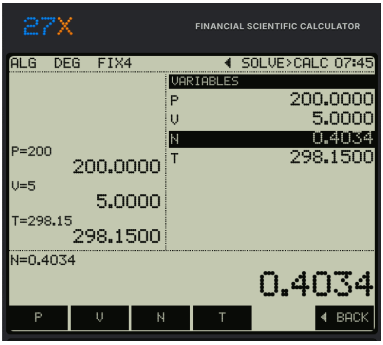
Ideal gas law

Pressure in kPa, volume in litres, temperature in kelvin. How many moles in 5 L at 200 kPa and 25 °C?

```
P×V=N×8.314462618×T
Name: Ideal gas
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
200 **‹P›**	P=200.0000	Stores 200 in P
5 **‹V›**	V=5.0000	Stores 5 in V
298.15 **‹T›**	T=298.1500	Stores 298.15 in T
‹N›	N=0.4034	Calculates N

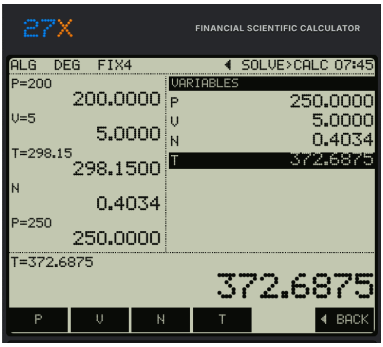
Result: N = **0.4034** mol



Then: At what temperature would those moles reach 250 kPa?

Keys	Display	What it does
250 ‹P›	P=250.0000	Stores 250 in P
‹T›	T=372.6875	Calculates T

Result: T = **372.6875** K



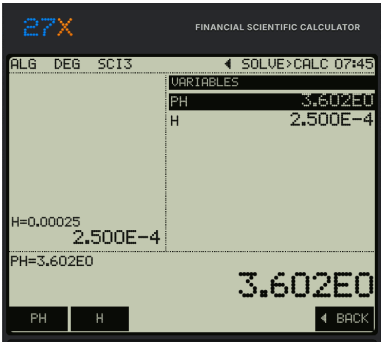
pH and hydrogen-ion concentration

A solution has [H⁺] = 0.00025 mol/L.

```
PH=-LOG(H)
Name: pH
```

Keys	Display	What it does
‹SOLVE›	0.000E0	Opens SOLVE
‹CALC›	0.000E0	Shows the variables
0.00025 **‹H›**	H=2.500E-4	Stores 0.00025 in H
‹PH›	PH=3.602E0	Calculates PH

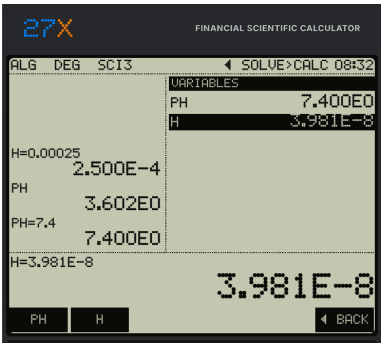
Result: PH = **3.602E0**



Then: What [H⁺] gives pH 7.4? Very small answers like this need no special guess.

Keys	Display	What it does
7.4 **‹PH›**	PH=7.400E0	Stores 7.4 in PH
‹H›	H=3.981E-8	Calculates H

Result: H = **3.981E-8** mol/L



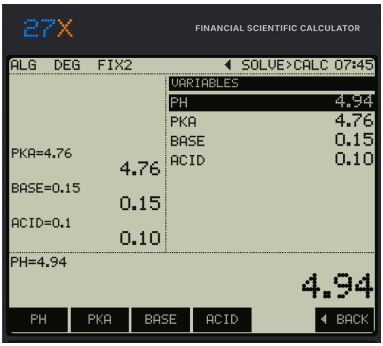
Buffer: Henderson–Hasselbalch

Acetate buffer, pKa 4.76, 0.15 M acetate and 0.10 M acetic acid.

```
PH=PKA+LOG(BASE÷ACID)
Name: Buffer pH
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
4.76 **‹PKA›**	PKA=4.76	Stores 4.76 in PKA
0.15 **‹BASE›**	BASE=0.15	Stores 0.15 in BASE
0.1 **‹ACID›**	ACID=0.10	Stores 0.1 in ACID
‹PH›	PH=4.94	Calculates PH

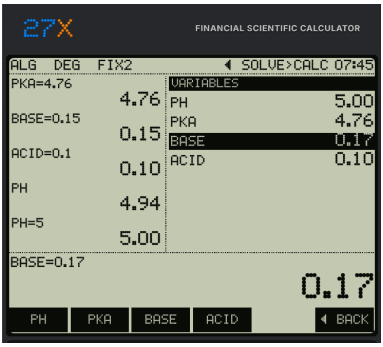
Result: PH = **4.94**



Then: How much acetate (BASE) for pH 5.00?

Keys	Display	What it does
5 **‹PH›**	PH=5.00	Stores 5 in PH
‹BASE›	BASE=0.17	Calculates BASE

Result: BASE = **0.17** M



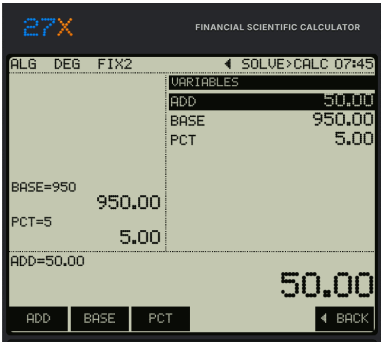
Adding an active to a fixed % of the final product

950 g of base cream must end up 5% active, by weight, once the active is added.

```
ADD=BASE×PCT÷(100−PCT)
Name: Active addition
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
950 **‹BASE›**	BASE=950.00	Stores 950 in BASE
5 **‹PCT›**	PCT=5.00	Stores 5 in PCT
‹ADD›	ADD=50.00	Calculates ADD

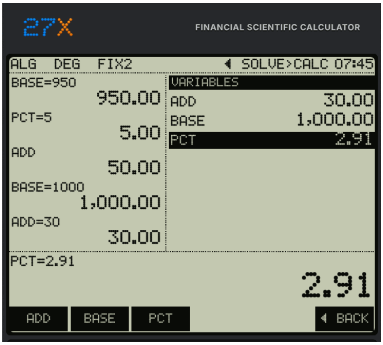
Result: ADD = **50.00** g



Then: 30 g was added to 1 000 g of base. What % is the final product?

Keys	Display	What it does
1000 **‹BASE›**	BASE=1,000.00	Stores 1000 in BASE
30 **‹ADD›**	ADD=30.00	Stores 30 in ADD
‹PCT›	PCT=2.91	Calculates PCT

Result: PCT = **2.91** %



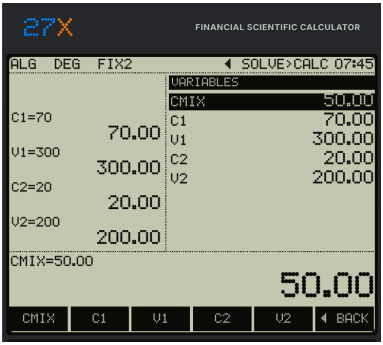
Mixing two strengths

300 mL of 70% alcohol mixed with 200 mL of 20%.

```
CMIX=(C1×V1+C2×V2)÷(V1+V2)
Name: Mixing
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
70 **‹C1›**	C1=70.00	Stores 70 in C1
300 **‹V1›**	V1=300.00	Stores 300 in V1
20 **‹C2›**	C2=20.00	Stores 20 in C2
200 **‹V2›**	V2=200.00	Stores 200 in V2
‹CMIX›	CMIX=50.00	Calculates CMIX

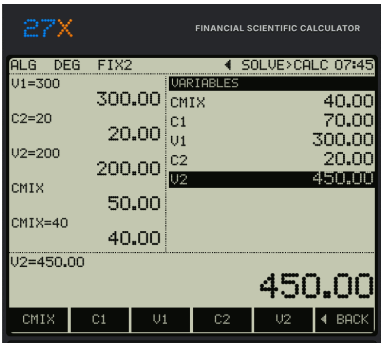
Result: CMIX = **50.00** %



Then: How much 20% to bring 300 mL of 70% down to 40%?

Keys	Display	What it does
40 **‹CMIX›**	CMIX=40.00	Stores 40 in CMIX
‹V2›	V2=450.00	Calculates V2

Result: V2 = **450.00** mL



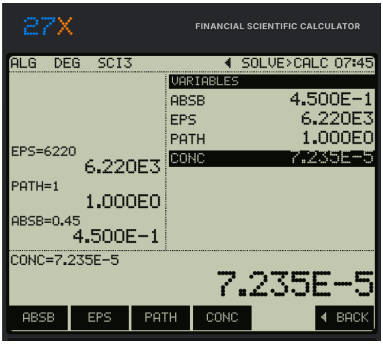
Beer–Lambert absorbance

NADH (ε = 6 220 L/mol·cm) reads 0.45 in a 1 cm cell.

```
ABSB=EPS×PATH×CONC
Name: Absorbance
```

Keys	Display	What it does
‹SOLVE›	0.000E0	Opens SOLVE
‹CALC›	0.000E0	Shows the variables
6220 **‹EPS›**	EPS=6.220E3	Stores 6220 in EPS
1 **‹PATH›**	PATH=1.000E0	Stores 1 in PATH
0.45 **‹ABSB›**	ABSB=4.500E-1	Stores 0.45 in ABSB
‹CONC›	CONC=7.235E-5	Calculates CONC

Result: CONC = **7.235E-5** mol/L



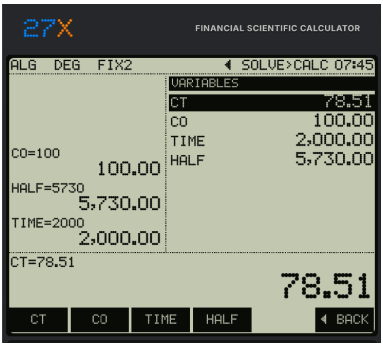
Half-life decay

Carbon-14 (half-life 5 730 years): how much of 100 units is left after 2 000 years?

```
CT=C0×EXP(−LN(2)×TIME÷HALF)
Name: Decay
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
100 **‹C0›**	C0=100.00	Stores 100 in C0
5730 **‹HALF›**	HALF=5,730.00	Stores 5730 in HALF
2000 **‹TIME›**	TIME=2,000.00	Stores 2000 in TIME
‹CT›	CT=78.51	Calculates CT

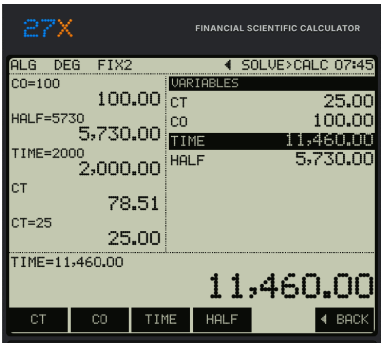
Result: CT = **78.51**



Then: How old is a sample with 25% left?

Keys	Display	What it does
25 **‹CT›**	CT=25.00	Stores 25 in CT
‹TIME›	TIME=11,460.00	Calculates TIME

Result: TIME = **11,460.00** years



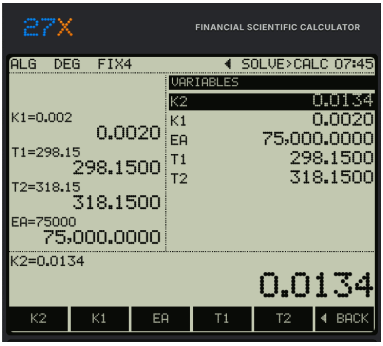
Rate constant at another temperature (Arrhenius)

k = 0.002 /s at 25 °C, activation energy 75 kJ/mol. What is k at 45 °C?

```
LN(K2÷K1)=EA÷8.314462618×(1÷T1−1÷T2)
Name: Arrhenius
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
0.002 **‹K1›**	K1=0.0020	Stores 0.002 in K1
298.15 **‹T1›**	T1=298.1500	Stores 298.15 in T1
318.15 **‹T2›**	T2=318.1500	Stores 318.15 in T2
75000 **‹EA›**	EA=75,000.0000	Stores 75 000 in EA
‹K2›	K2=0.0134	Calculates K2

Result: K2 = **0.0134** per second



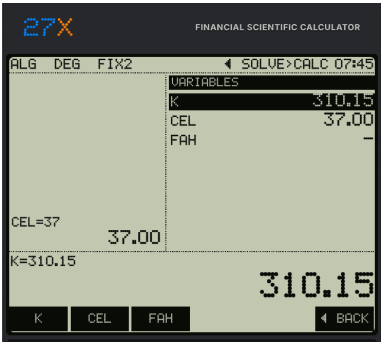
Temperature scales in one equation (S)

Tap K to get kelvin from °C; tap FAH or CEL to convert between °F and °C. 37 °C in kelvin:

```
IF(S(K):K=CEL+273.15:FAH=CEL×1.8+32)
```
Name: Temperatures

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
37 **‹CEL›**	CEL=37.00	Stores 37 in CEL
‹K›	K=310.15	Calculates K

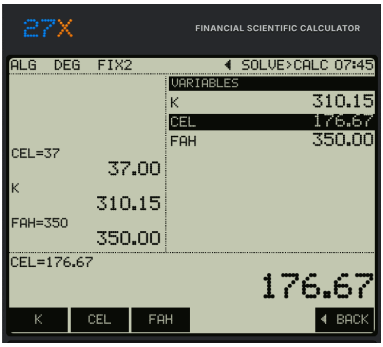
Result: K = **310.15** K



Then: And 350 °F in °C:

Keys	Display	What it does
350 **‹FAH›**	FAH=350.00	Stores 350 in FAH
‹CEL›	CEL=176.67	Calculates CEL

Result: CEL = **176.67** °C



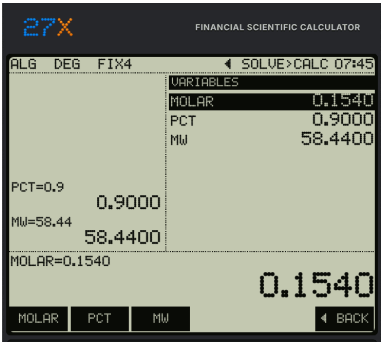
% w/v to molarity

Normal saline is 0.9% w/v NaCl (MW 58.44).

```
MOLAR=PCT×10÷MW
```
Name: Percent to molar

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
0.9 **‹PCT›**	PCT=0.9000	Stores 0.9 in PCT
58.44 **‹MW›**	MW=58.4400	Stores 58.44 in MW
‹MOLAR›	MOLAR=0.1540	Calculates MOLAR

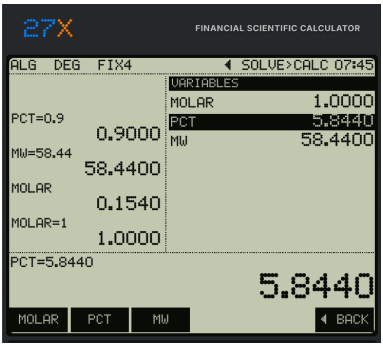
Result: MOLAR = **0.1540** M



Then: What % w/v is a 1 M solution?

Keys	Display	What it does
1 **‹MOLAR›**	MOLAR=1.0000	Stores 1 in MOLAR
‹PCT›	PCT=5.8440	Calculates PCT

Result: PCT = **5.8440** %



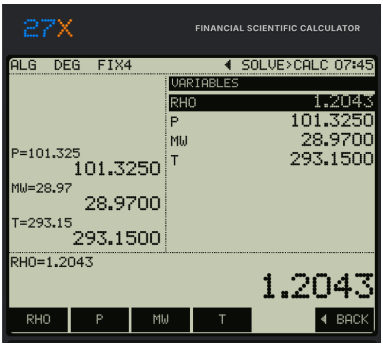
Gas density

Air (MW 28.97) at 101.325 kPa and 20 °C, in g/L.

```
RHO=P×MW÷(8.314462618×T)
Name: Gas density
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
101.325 **‹P›**	P=101.3250	Stores 101.325 in P
28.97 **‹MW›**	MW=28.9700	Stores 28.97 in MW
293.15 **‹T›**	T=293.1500	Stores 293.15 in T
‹RHO›	RHO=1.2043	Calculates RHO

Result: RHO = **1.2043** g/L



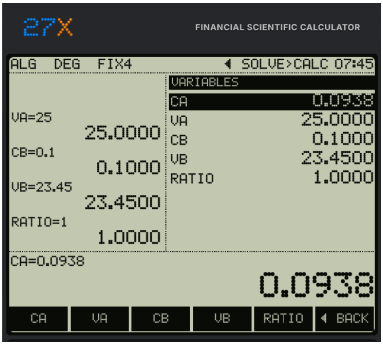
Titration

25 mL of acid needs 23.45 mL of 0.100 M NaOH; 1 mol base per mol acid (RATIO = 1).

```
CA×VA=CB×VB×RATIO
Name: Titration
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
25 **‹VA›**	VA=25.0000	Stores 25 in VA
0.1 **‹CB›**	CB=0.1000	Stores 0.1 in CB
23.45 **‹VB›**	VB=23.4500	Stores 23.45 in VB
1 **‹RATIO›**	RATIO=1.0000	Stores 1 in RATIO
‹CA›	CA=0.0938	Calculates CA

Result: CA = **0.0938** M



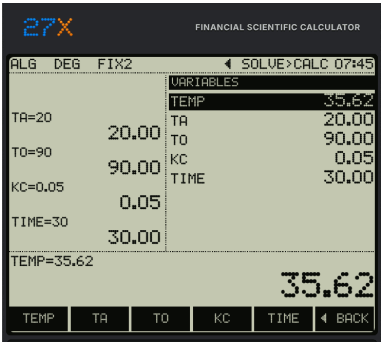
Cooling time (Newton's law)

A 90 °C batch in a 20 °C room cools with KC = 0.05 per minute. Temperature after 30 minutes:

```
TEMP=TA+(T0−TA)×EXP(−KC×TIME)
Name: Cooling
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
20 **‹TA›**	TA=20.00	Stores 20 in TA
90 **‹T0›**	T0=90.00	Stores 90 in T0
0.05 **‹KC›**	KC=0.05	Stores 0.05 in KC
30 **‹TIME›**	TIME=30.00	Stores 30 in TIME
‹TEMP›	TEMP=35.62	Calculates TEMP

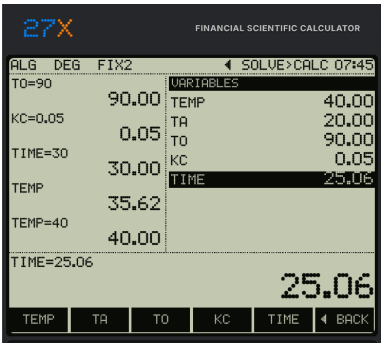
Result: TEMP = **35.62** °C



Then: When will it reach 40 °C?

Keys	Display	What it does
40 **‹TEMP›**	TEMP=40.00	Stores 40 in TEMP
‹TIME›	TIME=25.06	Calculates TIME

Result: TIME = **25.06** minutes



3. Electronics and electrical

Component values, filters and timing, power, decibels, transformers and sensors. Enter component values in base units (ohms, farads, henries) unless the equation says otherwise; use E for powers of ten, for example 1.5E-8 for 15 nF.

Example	Name
LED series resistor	LED resistor
Power and current from one equation (S)	Power and current
Voltage divider	Voltage divider
Two resistors in parallel	Parallel R
Capacitor charging	RC charging
RC filter cut-off	RC cut-off
LC resonance	Resonance
Capacitive reactance	Reactance
Power ratio in decibels	Decibels
555 timer (astable)	555 astable
Resistance of a copper wire	Wire resistance
Battery run time	Battery life
Non-inverting amplifier gain	Op-amp gain
Transformer turns	Transformer
NTC thermistor temperature	Thermistor

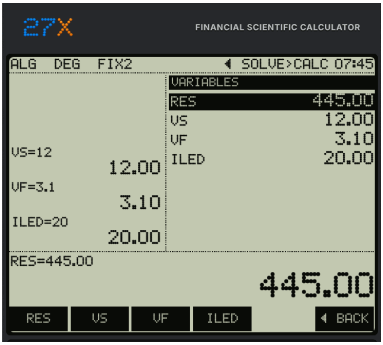
LED series resistor

A 12 V supply, a white LED dropping 3.1 V, at 20 mA.

```
RES=(VS−VF)÷(ILED÷1000)
Name: LED resistor
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
12 **‹VS›**	VS=12.00	Stores 12 in VS
3.1 **‹VF›**	VF=3.10	Stores 3.1 in VF
20 **‹ILED›**	ILED=20.00	Stores 20 in ILED
‹RES›	RES=445.00	Calculates RES

Result: RES = **445.00** Ω



Then: With a 470 Ω resistor, what current flows?

Keys	Display	What it does
470 **‹RES›**	RES=470.00	Stores 470 in RES
‹ILED›	ILED=18.94	Calculates ILED

Result: ILED = **18.94** mA



Power and current from one equation (S)

12 V across a 47 Ω resistor. Power in watts:

```
IF(S(PWR):PWR=V^2÷RES:CUR=V÷RES)
Name: Power and current
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
12 **‹V›**	V=12.00	Stores 12 in V
47 **‹RES›**	RES=47.00	Stores 47 in RES
‹PWR›	PWR=3.06	Calculates PWR

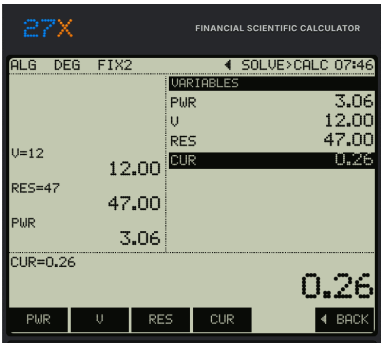
Result: PWR = **3.06** W



Then: Same values, tap CUR for the current in amps:

Keys	Display	What it does
‹CUR›	CUR=0.26	Calculates CUR

Result: CUR = **0.26** A



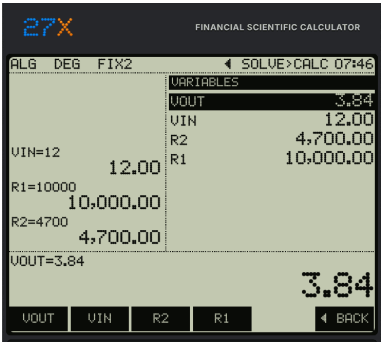
Voltage divider

12 V in, R1 = 10 kΩ, R2 = 4.7 kΩ.

```
VOUT=VIN×R2÷(R1+R2)
Name: Voltage divider
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
12 **‹VIN›**	VIN=12.00	Stores 12 in VIN
10000 **‹R1›**	R1=10,000.00	Stores 10 000 in R1
4700 **‹R2›**	R2=4,700.00	Stores 4700 in R2
‹VOUT›	VOUT=3.84	Calculates VOUT

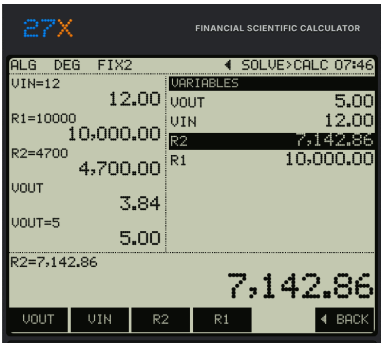
Result: VOUT = **3.84** V



Then: What R2 gives 5 V out?

Keys	Display	What it does
5 **‹VOUT›**	VOUT=5.00	Stores 5 in VOUT
‹R2›	R2=7,142.86	Calculates R2

Result: R2 = **7,142.86** Ω



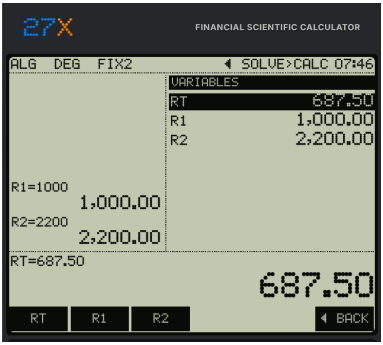
Two resistors in parallel

1 kΩ in parallel with 2.2 kΩ.

```
RT=1÷(1÷R1+1÷R2)
Name: Parallel R
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1000 **‹R1›**	R1=1,000.00	Stores 1000 in R1
2200 **‹R2›**	R2=2,200.00	Stores 2200 in R2
‹RT›	RT=687.50	Calculates RT

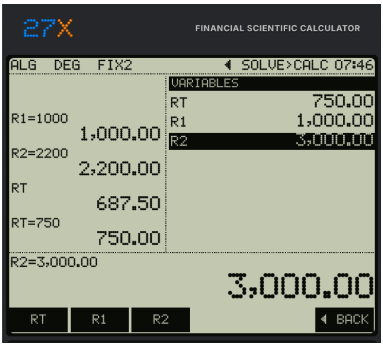
Result: RT = **687.50** Ω



Then: What goes in parallel with 1 kΩ to make 750 Ω?

Keys	Display	What it does
750 **‹RT›**	RT=750.00	Stores 750 in RT
‹R2›	R2=3,000.00	Calculates R2

Result: R2 = **3,000.00** Ω



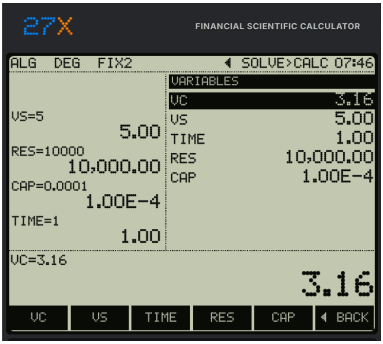
Capacitor charging

5 V through 10 kΩ into 100 µF (0.0001 F). Voltage after 1 second:

```
VC=VS×(1−EXP(−TIME÷(RES×CAP)))
Name: RC charging
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
5 **‹VS›**	VS=5.00	Stores 5 in VS
10000 **‹RES›**	RES=10,000.00	Stores 10 000 in RES
0.0001 **‹CAP›**	CAP=1.00E-4	Stores 0.0001 in CAP
1 **‹TIME›**	TIME=1.00	Stores 1 in TIME
‹VC›	VC=3.16	Calculates VC

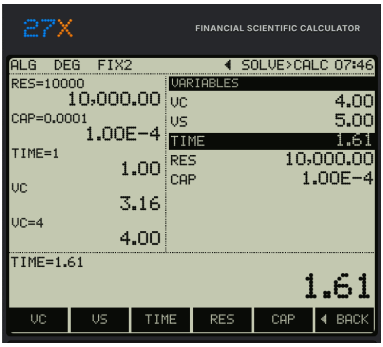
Result: VC = **3.16** V



Then: When does it reach 4 V?

Keys	Display	What it does
4 **‹VC›**	VC=4.00	Stores 4 in VC
‹TIME›	TIME=1.61	Calculates TIME

Result: TIME = **1.61** s



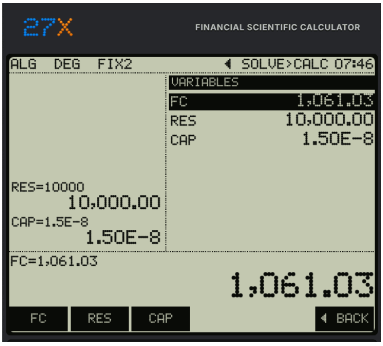
RC filter cut-off

10 kΩ with 15 nF (1.5E−8 F).

```
FC=1÷(2×π×RES×CAP)
Name: RC cut-off
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
10000 **‹RES›**	RES=10,000.00	Stores 10 000 in RES
1.5E-8 **‹CAP›**	CAP=1.50E-8	Stores 1.5E-8 in CAP
‹FC›	FC=1,061.03	Calculates FC

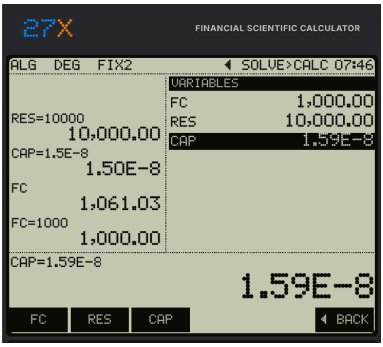
Result: FC = **1,061.03** Hz



Then: What capacitor gives 1 kHz with the same resistor?

Keys	Display	What it does
1000 **‹FC›**	FC=1,000.00	Stores 1000 in FC
‹CAP›	CAP=1.59E-8	Calculates CAP

Result: CAP = **1.59E-8** F



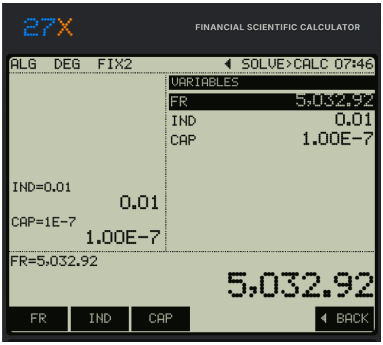
LC resonance

10 mH (0.01 H) with 100 nF (1E−7 F).

```
FR=1÷(2×π×SQRT(IND×CAP))
Name: Resonance
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
0.01 **‹IND›**	IND=0.01	Stores 0.01 in IND
1E-7 **‹CAP›**	CAP=1.00E-7	Stores 1E-7 in CAP
‹FR›	FR=5,032.92	Calculates FR

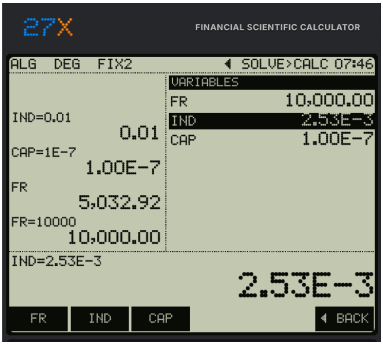
Result: FR = **5,032.92** Hz



Then: What inductance resonates at 10 kHz?

Keys	Display	What it does
10000 **‹FR›**	FR=10,000.00	Stores 10 000 in FR
‹IND›	IND=2.53E-3	Calculates IND

Result: IND = **2.53E-3** H



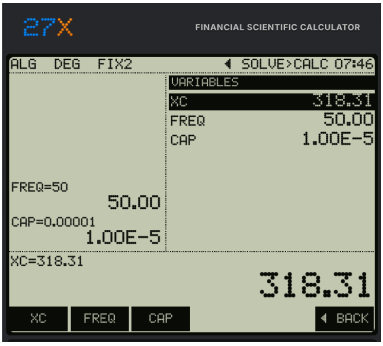
Capacitive reactance

10 µF (0.00001 F) at 50 Hz.

```
XC=1÷(2×π×FREQ×CAP)
Name: Reactance
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
50 **‹FREQ›**	FREQ=50.00	Stores 50 in FREQ
0.00001 **‹CAP›**	CAP=1.00E-5	Stores 0.00001 in CAP
‹XC›	XC=318.31	Calculates XC

Result: XC = **318.31** Ω



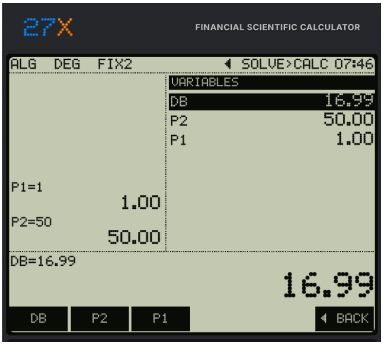
Power ratio in decibels

An amplifier turns 1 W into 50 W.

```
DB=10×LOG(P2÷P1)
Name: Decibels
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1 **‹P1›**	P1=1.00	Stores 1 in P1
50 **‹P2›**	P2=50.00	Stores 50 in P2
‹DB›	DB=16.99	Calculates DB

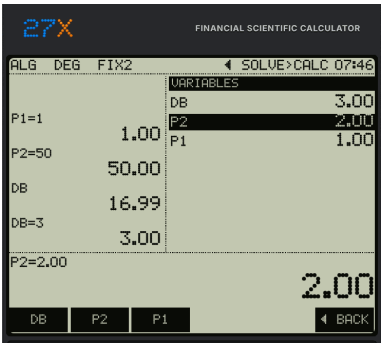
Result: DB = **16.99** dB



Then: What output is +3 dB?

Keys	Display	What it does
3 **‹DB›**	DB=3.00	Stores 3 in DB
‹P2›	P2=2.00	Calculates P2

Result: P2 = **2.00** W



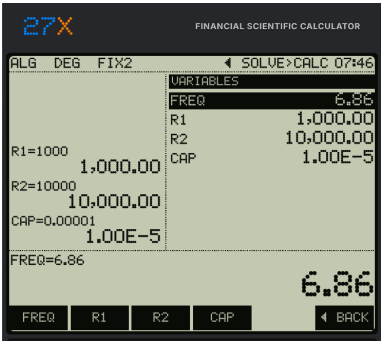
555 timer (astable)

R1 = 1 kΩ, R2 = 10 kΩ, C = 10 µF (0.00001 F).

```
FREQ=1.44÷((R1+2×R2)×CAP)
Name: 555 astable
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1000 **‹R1›**	R1=1,000.00	Stores 1000 in R1
10000 **‹R2›**	R2=10,000.00	Stores 10 000 in R2
0.00001 **‹CAP›**	CAP=1.00E-5	Stores 0.00001 in CAP
‹FREQ›	FREQ=6.86	Calculates FREQ

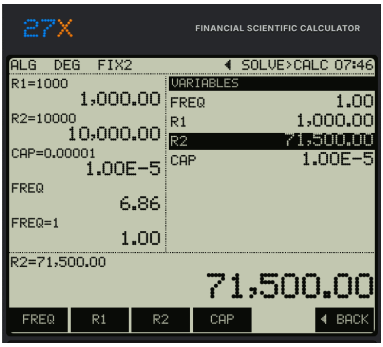
Result: FREQ = **6.86** Hz



Then: What R2 slows it to 1 Hz?

Keys	Display	What it does
1 **‹FREQ›**	FREQ=1.00	Stores 1 in FREQ
‹R2›	R2=71,500.00	Calculates R2

Result: R2 = **71,500.00** Ω



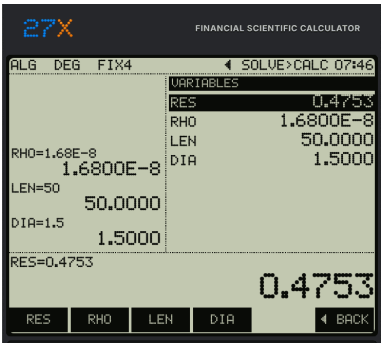
Resistance of a copper wire

50 m of 1.5 mm copper (resistivity 1.68E−8 Ω·m). DIA is in mm.

```
RES=RHO×LEN÷(π×(DIA÷2000)^2)
Name: Wire resistance
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
1.68E-8 **‹RHO›**	RHO=1.6800E-8	Stores 1.68E-8 in RHO
50 **‹LEN›**	LEN=50.0000	Stores 50 in LEN
1.5 **‹DIA›**	DIA=1.5000	Stores 1.5 in DIA
‹RES›	RES=0.4753	Calculates RES

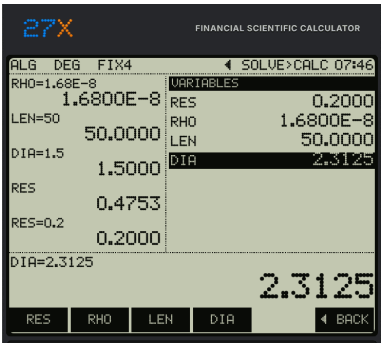
Result: RES = **0.4753** Ω



Then: What diameter keeps it to 0.2 Ω?

Keys	Display	What it does
0.2 **‹RES›**	RES=0.2000	Stores 0.2 in RES
‹DIA›	DIA=2.3125	Calculates DIA

Result: DIA = **2.3125** mm



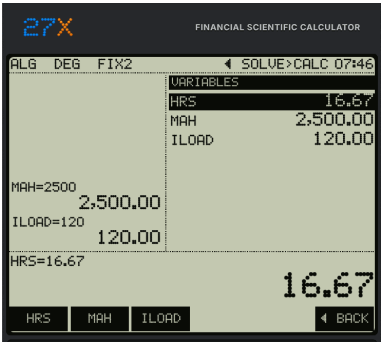
Battery run time

A 2 500 mAh pack, using 80% of it, at 120 mA.

```
HRS=MAH×0.8÷ILOAD
Name: Battery life
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
2500 **‹MAH›**	MAH=2,500.00	Stores 2500 in MAH
120 **‹ILOAD›**	ILOAD=120.00	Stores 120 in ILOAD
‹HRS›	HRS=16.67	Calculates HRS

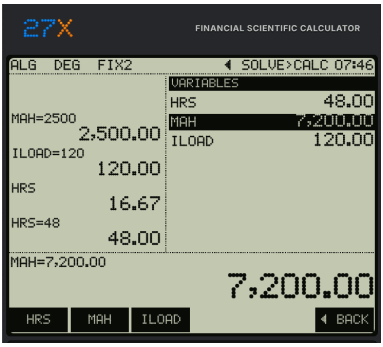
Result: HRS = **16.67** hours



Then: What capacity runs 48 hours?

Keys	Display	What it does
48 **‹HRS›**	HRS=48.00	Stores 48 in HRS
‹MAH›	MAH=7,200.00	Calculates MAH

Result: MAH = **7,200.00** mAh



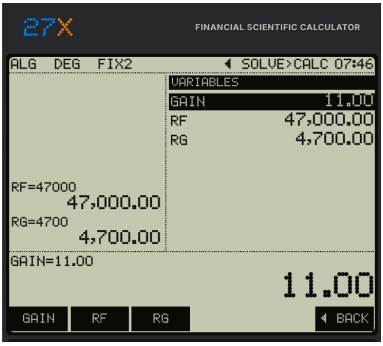
Non-inverting amplifier gain

RF = 47 kΩ, RG = 4.7 kΩ.

```
GAIN=1+RF÷RG
Name: Op-amp gain
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
47000 **‹RF›**	RF=47,000.00	Stores 47 000 in RF
4700 **‹RG›**	RG=4,700.00	Stores 4700 in RG
‹GAIN›	GAIN=11.00	Calculates GAIN

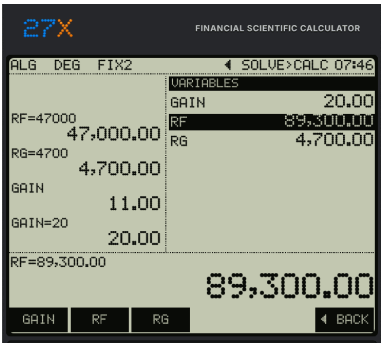
Result: GAIN = **11.00**



Then: What RF gives a gain of 20?

Keys	Display	What it does
20 **‹GAIN›**	GAIN=20.00	Stores 20 in GAIN
‹RF›	RF=89,300.00	Calculates RF

Result: RF = **89,300.00** Ω



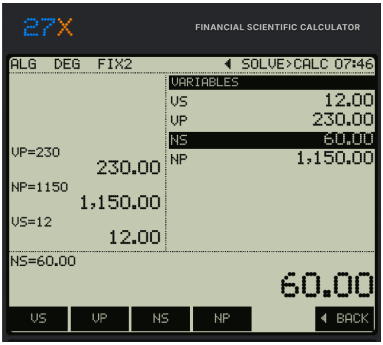
Transformer turns

230 V primary with 1 150 turns. How many secondary turns for 12 V?

VS÷VP=NS÷NP
Name: Transformer

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
230 **‹VP›**	VP=230.00	Stores 230 in VP
1150 **‹NP›**	NP=1,150.00	Stores 1150 in NP
12 **‹VS›**	VS=12.00	Stores 12 in VS
‹NS›	NS=60.00	Calculates NS

Result: NS = **60.00** turns



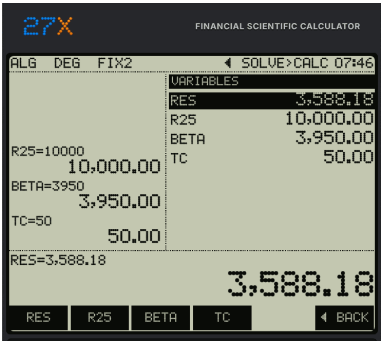
NTC thermistor temperature

A 10 kΩ NTC (β = 3 950). Its resistance at 50 °C:

```
RES=R25×EXP(BETA×(1÷(TC+273.15)−1÷298.15))
```
Name: Thermistor

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
10000 **‹R25›**	R25=10,000.00	Stores 10 000 in R25
3950 **‹BETA›**	BETA=3,950.00	Stores 3950 in BETA
50 **‹TC›**	TC=50.00	Stores 50 in TC
‹RES›	RES=3,588.18	Calculates RES

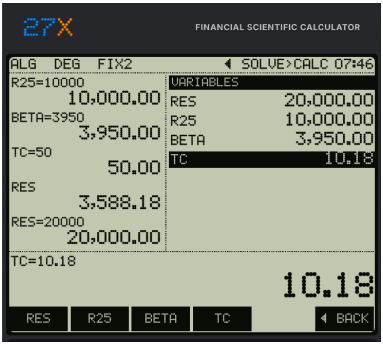
Result: RES = **3,588.18** Ω



Then: It reads 20 kΩ. What is the temperature?

Keys	Display	What it does
20000 **‹RES›**	RES=20,000.00	Stores 20 000 in RES
‹TC›	TC=10.18	Calculates TC

Result: TC = **10.18** °C



4. Engineering, physics and mathematics

Motion, flow, structures, heat and radiation, geometry, series and statistics. Angles are in degrees (the calculator's DEG mode).

Example	Name
Projectile range	Projectile range
Distance under constant acceleration	Motion
Pendulum period	Pendulum
Kinetic energy	Kinetic energy
Flow in a pipe	Pipe flow
Reynolds number	Reynolds
Beam deflection, centre load	Beam deflection
Heat loss through a wall	Conduction
Time to heat water	Heating time
Heat radiated (Stefan–Boltzmann)	Radiation
Third side of a triangle (law of cosines)	Law of cosines
Area of a circular segment	Segment area
Liquid in a horizontal tank (dip chart)	Tank volume
Total distance of a bouncing ball (Σ)	Bouncing ball
Sample size for a survey	Sample size

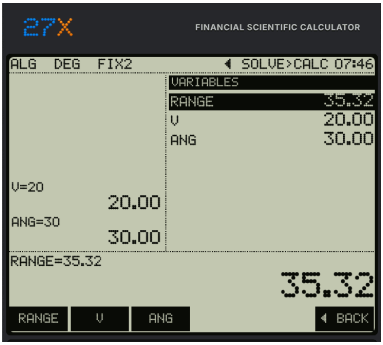
Projectile range

Launched at 20 m/s at 30° (degrees mode), on level ground.

```
RANGE=V^2×SIN(2×ANG)÷9.80665
Name: Projectile range
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
20 **‹V›**	V=20.00	Stores 20 in V
30 **‹ANG›**	ANG=30.00	Stores 30 in ANG
‹RANGE›	RANGE=35.32	Calculates RANGE

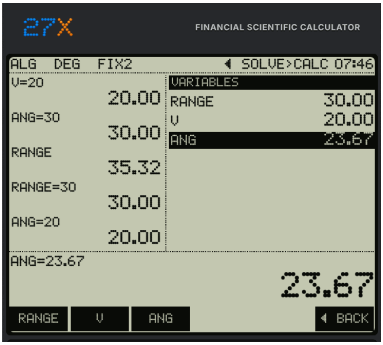
Result: RANGE = **35.32** m



Then: What angle lands it at 30 m? Two angles work; a guess of 20° finds the low one.

Keys	Display	What it does
30 **‹RANGE›**	RANGE=30.00	Stores 30 in RANGE
20 **‹ANG›**	ANG=20.00	Stores 20 in ANG
‹ANG›	ANG=23.67	Calculates ANG

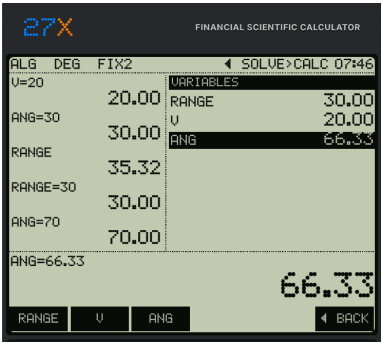
Result: ANG = **23.67 °**



Then: A guess of 70° finds the high one.

Keys	Display	What it does
30 **‹RANGE›**	RANGE=30.00	Stores 30 in RANGE
70 **‹ANG›**	ANG=70.00	Stores 70 in ANG
‹ANG›	ANG=66.33	Calculates ANG

Result: ANG = **66.33** °



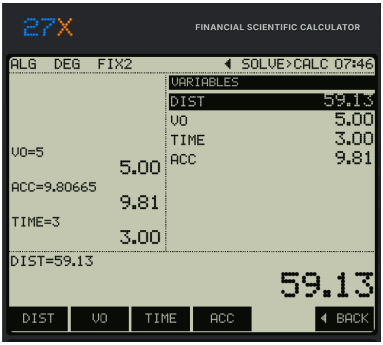
Distance under constant acceleration

Dropped with a downward start of 5 m/s (ACC = 9.80665). Distance in 3 s:

```
DIST=V0×TIME+0.5×ACC×TIME^2
Name: Motion
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
5 **‹V0›**	V0=5.00	Stores 5 in V0
9.80665 **‹ACC›**	ACC=9.81	Stores 9.80665 in ACC
3 **‹TIME›**	TIME=3.00	Stores 3 in TIME
‹DIST›	DIST=59.13	Calculates DIST

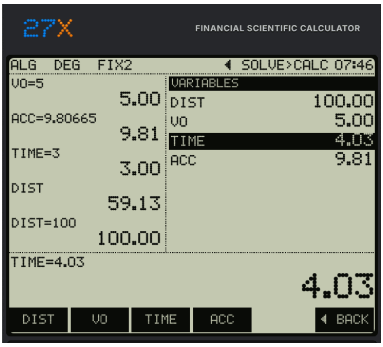
Result: DIST = **59.13** m



Then: How long to fall 100 m?

Keys	Display	What it does
100 **‹DIST›**	DIST=100.00	Stores 100 in DIST
‹TIME›	TIME=4.03	Calculates TIME

Result: TIME = **4.03** s



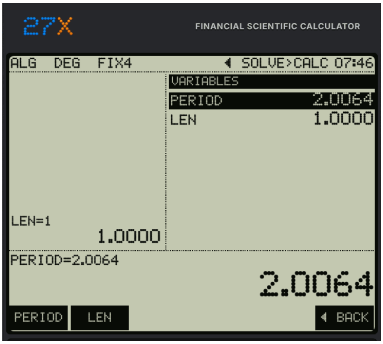
Pendulum period

A 1 m pendulum.

```
PERIOD=2×π×SQRT(LEN÷9.80665)
Name: Pendulum
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
1 **‹LEN›**	LEN=1.0000	Stores 1 in LEN
‹PERIOD›	PERIOD=2.0064	Calculates PERIOD

Result: PERIOD = **2.0064** s



Then: What length beats exactly 1 second?

Keys	Display	What it does
1 **‹PERIOD›**	PERIOD=1.0000	Stores 1 in PERIOD
‹LEN›	LEN=0.2484	Calculates LEN

Result: LEN = **0.2484** m



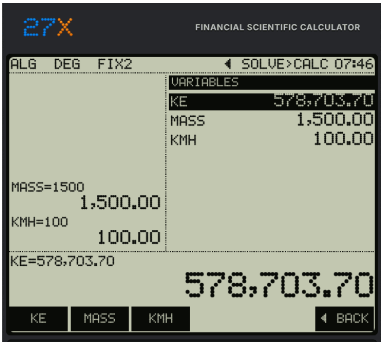
Kinetic energy

A 1 500 kg car at 100 km/h, in joules.

```
KE=0.5×MASS×(KMH÷3.6)^2
Name: Kinetic energy
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1500 **‹MASS›**	MASS=1,500.00	Stores 1500 in MASS
100 **‹KMH›**	KMH=100.00	Stores 100 in KMH
‹KE›	KE=578,703.70	Calculates KE

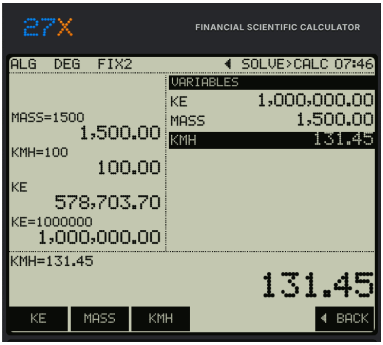
Result: KE = **578,703.70** J



Then: At what speed does it carry 1 MJ?

Keys	Display	What it does
1000000 **‹KE›**	KE=1,000,000.00	Stores 1 000 000 in KE
‹KMH›	KMH=131.45	Calculates KMH

Result: KMH = **131.45** km/h



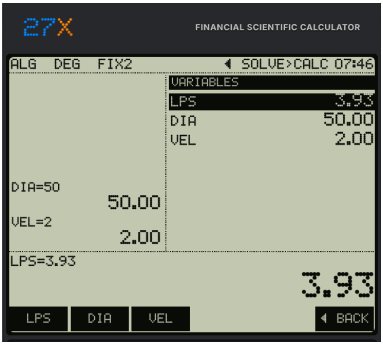
Flow in a pipe

A 50 mm pipe with water at 2 m/s, in litres per second.

```
LPS=π×(DIA÷2000)^2×VEL×1000
Name: Pipe flow
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
50 **‹DIA›**	DIA=50.00	Stores 50 in DIA
2 **‹VEL›**	VEL=2.00	Stores 2 in VEL
‹LPS›	LPS=3.93	Calculates LPS

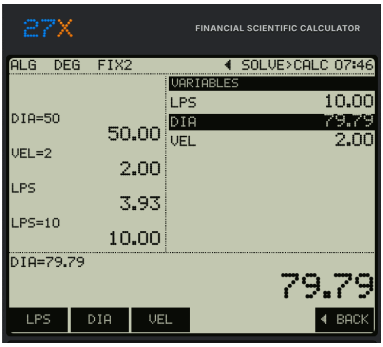
Result: LPS = **3.93** L/s



Then: What pipe carries 10 L/s at the same speed?

Keys	Display	What it does
10 **‹LPS›**	LPS=10.00	Stores 10 in LPS
‹DIA›	DIA=79.79	Calculates DIA

Result: DIA = **79.79** mm



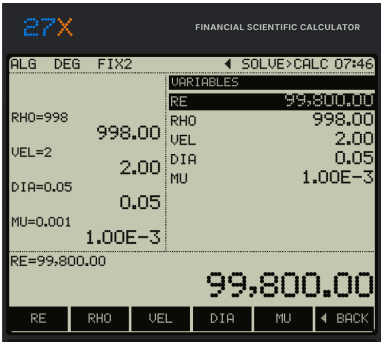
Reynolds number

Water (ρ = 998 kg/m³, μ = 0.001 Pa·s) at 2 m/s in a 0.05 m pipe. Above about 4 000 the flow is turbulent.

```
RE=RHO×VEL×DIA÷MU
Name: Reynolds
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
998 **‹RHO›**	RHO=998.00	Stores 998 in RHO
2 **‹VEL›**	VEL=2.00	Stores 2 in VEL
0.05 **‹DIA›**	DIA=0.05	Stores 0.05 in DIA
0.001 **‹MU›**	MU=1.00E-3	Stores 0.001 in MU
‹RE›	RE=99,800.00	Calculates RE

Result: RE = **99,800.00**



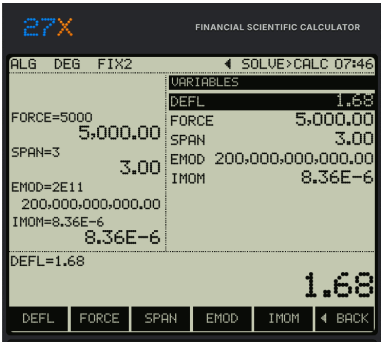
Beam deflection, centre load

Simply supported 3 m steel beam (E = 200E9 Pa, I = 8.36E−6 m⁴) with 5 kN at mid-span. Deflection in mm:

```
DEFL=FORCE×SPAN^3÷(48×EMOD×IMOM)×1000
```
Name: Beam deflection

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
5000 **‹FORCE›**	FORCE=5,000.00	Stores 5000 in FORCE
3 **‹SPAN›**	SPAN=3.00	Stores 3 in SPAN
2E11 **‹EMOD›**	EMOD=200,000,000,000.00	Stores 2E11 in EMOD
8.36E-6 **‹IMOM›**	IMOM=8.36E-6	Stores 8.36E-6 in IMOM
‹DEFL›	DEFL=1.68	Calculates DEFL

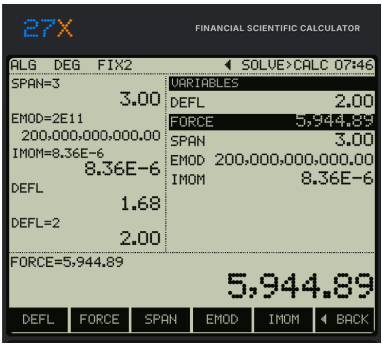
Result: DEFL = **1.68** mm



Then: What load deflects it 2 mm?

Keys	Display	What it does
2 **‹DEFL›**	DEFL=2.00	Stores 2 in DEFL
‹FORCE›	FORCE=5,944.89	Calculates FORCE

Result: FORCE = **5,944.89** N



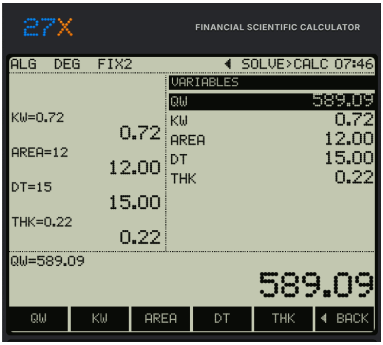
Heat loss through a wall

12 m² of 0.22 m brick (k = 0.72 W/m·K) with 15 °C between inside and out.

```
QW=KW×AREA×DT÷THK
Name: Conduction
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
0.72 **‹KW›**	KW=0.72	Stores 0.72 in KW
12 **‹AREA›**	AREA=12.00	Stores 12 in AREA
15 **‹DT›**	DT=15.00	Stores 15 in DT
0.22 **‹THK›**	THK=0.22	Stores 0.22 in THK
‹QW›	QW=589.09	Calculates QW

Result: QW = **589.09** W



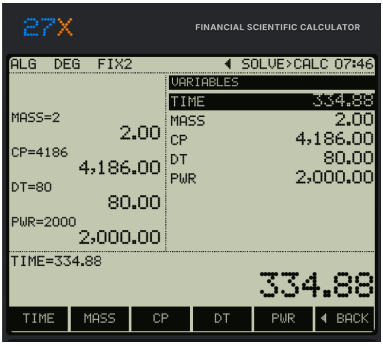
Time to heat water

2 kg of water (CP = 4 186 J/kg·K) heated by 80 °C with a 2 kW element.

```
TIME=MASS×CP×DT÷PWR
Name: Heating time
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
2 **‹MASS›**	MASS=2.00	Stores 2 in MASS
4186 **‹CP›**	CP=4,186.00	Stores 4186 in CP
80 **‹DT›**	DT=80.00	Stores 80 in DT
2000 **‹PWR›**	PWR=2,000.00	Stores 2000 in PWR
‹TIME›	TIME=334.88	Calculates TIME

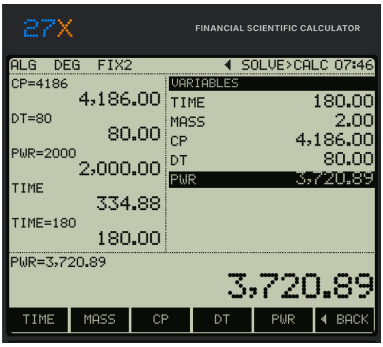
Result: TIME = **334.88** s



Then: What element boils it in 3 minutes (180 s)?

Keys	Display	What it does
180 **‹TIME›**	TIME=180.00	Stores 180 in TIME
‹PWR›	PWR=3,720.89	Calculates PWR

Result: PWR = **3,720.89** W



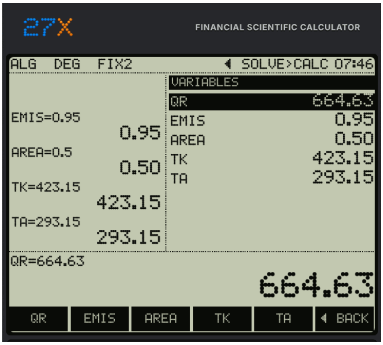
Heat radiated (Stefan–Boltzmann)

0.5 m² of black-painted steel (emissivity 0.95) at 150 °C (423.15 K) in a 20 °C (293.15 K) room.

```
QR=5.670374419E-8×EMIS×AREA×(TK^4-TA^4)
Name: Radiation
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
0.95 **‹EMIS›**	EMIS=0.95	Stores 0.95 in EMIS
0.5 **‹AREA›**	AREA=0.50	Stores 0.5 in AREA
423.15 **‹TK›**	TK=423.15	Stores 423.15 in TK
293.15 **‹TA›**	TA=293.15	Stores 293.15 in TA
‹QR›	QR=664.63	Calculates QR

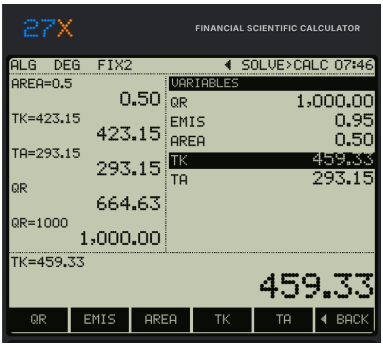
Result: QR = **664.63** W



Then: What surface temperature radiates 1 kW?

Keys	Display	What it does
1000 **‹QR›**	QR=1,000.00	Stores 1000 in QR
‹TK›	TK=459.33	Calculates TK

Result: TK = **459.33** K



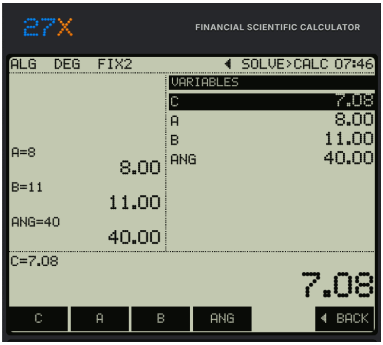
Third side of a triangle (law of cosines)

Sides of 8 and 11 with 40° between them.

```
C=SQRT(A^2+B^2−2×A×B×COS(ANG))
```
Name: Law of cosines

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
8 **‹A›**	A=8.00	Stores 8 in A
11 **‹B›**	B=11.00	Stores 11 in B
40 **‹ANG›**	ANG=40.00	Stores 40 in ANG
‹C›	C=7.08	Calculates C

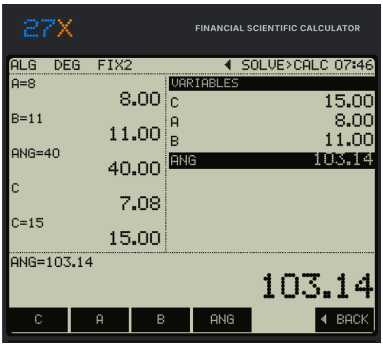
Result: C = **7.08**



Then: What angle makes the third side 15?

Keys	Display	What it does
15 **‹C›**	C=15.00	Stores 15 in C
‹ANG›	ANG=103.14	Calculates ANG

Result: ANG = **103.14 °**



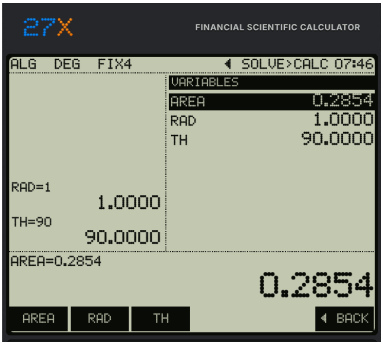
Area of a circular segment

Radius 1 m, angle 90°.

```
AREA=RAD^2÷2×(TH×π÷180−SIN(TH))
Name: Segment area
```

Keys	Display	What it does
‹SOLVE›	0.0000	Opens SOLVE
‹CALC›	0.0000	Shows the variables
1 **‹RAD›**	RAD=1.0000	Stores 1 in RAD
90 **‹TH›**	TH=90.0000	Stores 90 in TH
‹AREA›	AREA=0.2854	Calculates AREA

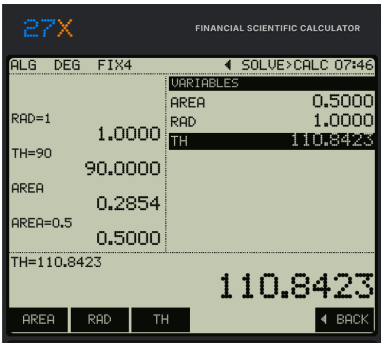
Result: AREA = **0.2854** m²



Then: What angle gives an area of 0.5 m²?

Keys	Display	What it does
0.5 **‹AREA›**	AREA=0.5000	Stores 0.5 in AREA
‹TH›	TH=110.8423	Calculates TH

Result: TH = **110.8423** °



Liquid in a horizontal tank (dip chart)

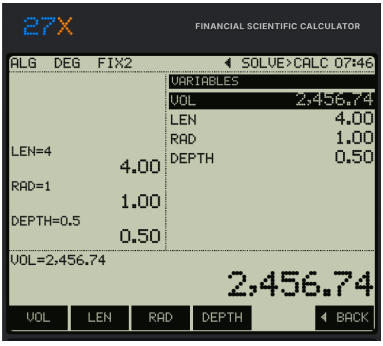
A 4 m long tank, radius 1 m, with liquid 0.5 m deep. Volume in litres:

```
VOL=LEN×(RAD^2×ACOS((RAD−DEPTH)÷RAD)×π÷180−(RAD−
DEPTH)×SQRT(2×RAD×DEPTH−DEPTH^2))×1000
```

Name: Tank volume

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
4 **‹LEN›**	LEN=4.00	Stores 4 in LEN
1 **‹RAD›**	RAD=1.00	Stores 1 in RAD
0.5 **‹DEPTH›**	DEPTH=0.50	Stores 0.5 in DEPTH
‹VOL›	VOL=2,456.74	Calculates VOL

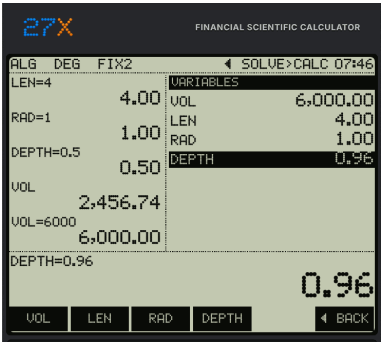
Result: VOL = **2,456.74** L



Then: How deep is 6 000 L?

Keys	Display	What it does
6000 **‹VOL›**	VOL=6,000.00	Stores 6000 in VOL
‹DEPTH›	DEPTH=0.96	Calculates DEPTH

Result: DEPTH = **0.96** m



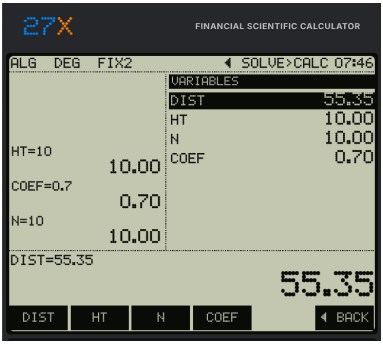
Total distance of a bouncing ball (Σ)

Dropped from 10 m; each bounce reaches 70% of the last (COEF = 0.7). Distance after 10 bounces:

```
DIST=HT+Σ(K:1:N:1:2×HT×COEF^K)
Name: Bouncing ball
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
10 **‹HT›**	HT=10.00	Stores 10 in HT
0.7 **‹COEF›**	COEF=0.70	Stores 0.7 in COEF
10 **‹N›**	N=10.00	Stores 10 in N
‹DIST›	DIST=55.35	Calculates DIST

Result: DIST = **55.35** m



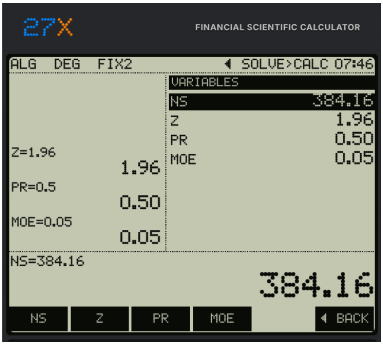
Sample size for a survey

95% confidence (Z = 1.96), worst-case proportion 0.5, margin of error ±5% (0.05).

```
NS=Z^2×PR×(1−PR)÷MOE^2
Name: Sample size
```

Keys	Display	What it does
‹SOLVE›	0.00	Opens SOLVE
‹CALC›	0.00	Shows the variables
1.96 **‹Z›**	Z=1.96	Stores 1.96 in Z
0.5 **‹PR›**	PR=0.50	Stores 0.5 in PR
0.05 **‹MOE›**	MOE=0.05	Stores 0.05 in MOE
‹NS›	NS=384.16	Calculates NS

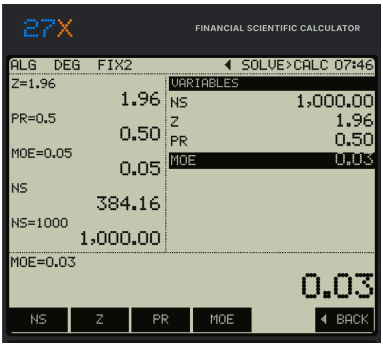
Result: NS = **384.16** people



Then: What margin does a sample of 1 000 give?

Keys	Display	What it does
1000 **‹NS›**	NS=1,000.00	Stores 1000 in NS
‹MOE›	MOE=0.03	Calculates MOE

Result: MOE = **0.03**



Index of equations

All the equations in this guide, by chapter, as you type them.

Business and finance

Name	Equation
Price from margin	PRICE=COST÷(1-MAR÷100)
Break-even	UNITS=FIXED÷(PRICE-VARC)
Simple interest	INTR=PV×RATE÷100×DAYS÷365
Growth rate	FV=PV×(1+R÷100)^N
Loan repayment	PMT=PV×(R÷1200)÷(1-(1+R÷1200)^-N)
VAT	GROSS=NET×(1+VAT÷100)
Quantity discount	PAY=QTY×PRICE×(1-IF(QTY≥100:0.15:IF(QTY≥50:0.1:0)))
Weekly pay	PAY=RATE×MIN(HRS:45)+IF(HRS>45:1.5×RATE×(HRS-45):0)
Book value	BOOK=COST-(COST-SALV)×YR÷LIFE
Order quantity	EOQ=SQRT(2×DEMAND×ORDER÷HOLD)
Growing cash flows	NPV=-INV+Σ(K:1:N:1:CF×(1+GR÷100)^K-1÷(1+R÷100)^K)
Effective rate	EFF=100×((1+NOM÷100÷M)^M-1)
Doubling time	N=LN(2)÷LN(1+R÷100)
Savings goal	FV=PMT×((1+R÷1200)^N-1)÷(R÷1200)
Profit	PROFIT=L(REV:UNITS×PRICE)-G(REV)×COMM÷100-UNITS×UCOST-FIXED

Laboratory, chemistry and formulation

Name	Equation
Dilution	C1×V1=C2×V2
Molar mass	MASS=MOLAR×VOL÷1000×MW
Ideal gas	P×V=N×8.314462618×T
pH	PH=-LOG(H)
Buffer pH	PH=PKA+LOG(BASE÷ACID)
Active addition	ADD=BASE×PCT÷(100-PCT)
Mixing	CMIX=(C1×V1+C2×V2)÷(V1+V2)
Absorbance	ABSB=EPS×PATH×CONC
Decay	CT=C0×EXP(-LN(2)×TIME÷HALF)
Arrhenius	LN(K2÷K1)=EA÷8.314462618×(1÷T1-1÷T2)
Temperatures	IF(S(K):K=CEL+273.15:FAH=CEL×1.8+32)
Percent to molar	MOLAR=PCT×10÷MW
Gas density	RHO=P×MW÷(8.314462618×T)
Titration	CA×VA=CB×VB×RATIO
Cooling	TEMP=TA+(T0-TA)×EXP(-KC×TIME)

Electronics and electrical

Name	Equation
LED resistor	RES=(VS-VF)÷(ILED÷1000)
Power and current	IF(S(PWR):PWR=V^2÷RES:CUR=V÷RES)
Voltage divider	VOUT=VIN×R2÷(R1+R2)

Name	Equation
Parallel R	RT=1÷(1÷R1+1÷R2)
RC charging	VC=VS×(1-EXP(-TIME÷(RES×CAP)))
RC cut-off	FC=1÷(2×π×RES×CAP)
Resonance	FR=1÷(2×π×SQRT(IND×CAP))
Reactance	XC=1÷(2×π×FREQ×CAP)
Decibels	DB=10×LOG(P2÷P1)
555 astable	FREQ=1.44÷((R1+2×R2)×CAP)
Wire resistance	RES=RHO×LEN÷(π×(DIA÷2000)^2)
Battery life	HRS=MAH×0.8÷ILOAD
Op-amp gain	GAIN=1+RF÷RG
Transformer	VS÷VP=NS÷NP
Thermistor	RES=R25×EXP(BETA×(1÷(TC+273.15)-1÷298.15))

Engineering, physics and mathematics

Name	Equation
Projectile range	RANGE=V^2×SIN(2×ANG)÷9.80665
Motion	DIST=V0×TIME+0.5×ACC×TIME^2
Pendulum	PERIOD=2×π×SQRT(LEN÷9.80665)
Kinetic energy	KE=0.5×MASS×(KMH÷3.6)^2
Pipe flow	LPS=π×(DIA÷2000)^2×VEL×1000
Reynolds	RE=RHO×VEL×DIA÷MU
Beam deflection	DEFL=FORCE×SPAN^3÷(48×EMOD×IMOM)×1000

Name	Equation
Conduction	QW=KW×AREA×DT÷THK
Heating time	TIME=MASS×CP×DT÷PWR
Radiation	QR=5.670374419E-8×EMIS×AREA×(TK^4-TA^4)
Law of cosines	C=SQRT(A^2+B^2-2×A×B×COS(ANG))
Segment area	AREA=RAD^2÷2×(TH×π÷180-SIN(TH))
Tank volume	VOL=LEN×(RAD^2×ACOS((RAD-DEPTH)÷RAD)×π÷180-(RAD-DEPTH)×SQRT(2×RAD×DEPTH-DEPTH^2))×1000
Bouncing ball	DIST=HT+Σ(K:1:N:1:2×HT×COEF^K)
Sample size	NS=Z^2×PR×(1-PR)÷MOE^2