Program 1: Quadratic Formula

	49 bytes
1	? → A : ? → B : ? → C : -B ÷ 2A → M ◢
2	C – AM^2 ◢ -4A Ans → C ◢
3	M + √Ans ÷ 2A → A ◢
4	2M – Ans → B

Given a function: $y = ax^2 + bx + c$, find the coordinates of vertex, the discriminant and the roots

Input: 1st: *a* 2nd: *b* 3rd: *c*

Display:

1st: *x*-coordinate of vertex

2nd: *y*-coordinate of vertex

3rd: discriminant ($\Delta = b^2 - 4ac$)

4th: 1st root (1st *x*-intercept)

5th: 2nd root (2nd *x*-intercept)

<u>Example</u>:

Given a Quadratic Function: $y = x^2 + 3x - 4$

[Prog] [1]

[1] [EXE] [3] [EXE] [–4] [EXE]

1st Display: –1.5 (*x*-coordinates of vertex)

[EXE]

2nd Display: –6.25 (*y*-coordinates of vertex)

[EXE]

3rd Display: 25 (discriminant)

[EXE]

4th Display: 1 (root)

[EXE]

5th Display: –4 (root)

Program 2: Simultaneous Equations

	151 bytes
1	? → D : ? → X : ? → Y : ? → C : ? → B : ? → A :
2	CX^2 – DXB + AD^2 → C : ? → M : 2YAD – MX^2 – BXY → M :
3	? → B : DXB M+ : AY^2 + XYB → A : ? → B : A – BX^2 → A :
4	C => Goto 1 : A ┘ M : Goto 2 : Lbl 1 :
5	(√(M^2 – 4AC) + M) ┘ (2C → A ◢ (Y – DA) ┘ X ◢
6	M ┘ C – A : Lbl 2 : Ans ◢ (Y – D Ans) ┘ X

Given a system of simultaneous equations, find the solutions.

Case 1: One Linear Equation and One Quadratic Equation, i.e.

$$\begin{cases} Px + Qy = R \\ Ax^2 + Bxy + Cx^2 + Dx + Ey = F \end{cases}$$

Input:

1st: *P* 2nd: *Q* 3rd: *R* 4th: *A* 5th: *B* 6th: *C* 7th: *D* 8th: *E* 9th: *F*

Display:

1st: x_1

2nd: y_1

(The first set of solution is (x_1, y_1))

3rd: x_2

4th: y_2

(The second set of solution is (x_2, y_2))

Example:

Solve $\begin{cases} x + 2y = 5 \\ x^2 + 2xy + y^2 + 3x + 4y = 20 \end{cases}$.

[Prog] [2]

[1] [EXE] [2] [EXE] [5] [EXE] [1] [EXE] [2] [EXE] [1] [EXE] [3] [EXE] [4] [EXE] [20] [EXE]

1st Display : 1

[EXE]

2nd Display : 2 (The first set of solution is $x = 1$ and $y = 2$)

[EXE]

3rd Display: -15

[EXE]

4th Display: 10 (The second set of solution is $x = -15$ and $y = 10$)

Case 2: Two Linear Equations, i.e.

$$\begin{cases} Ax + By = C \\ Dx + Ey = F \end{cases}$$

Input:

1st: A 2nd: B 3rd: C 4th: D 5th: E 6th: F

Display:

1st: x_1

2nd: y_1

(The set of solution is (x_1, y_1))

Example:

Solve $\begin{cases} 3x + 4y = 10 \\ x + 3y = 5 \end{cases}$.

[Prog] [2]

[3] [EXE] [4] [EXE] [10] [EXE] [0] EXE] [0] [EXE] [0] [EXE] [1] [EXE] [3] [EXE] [5] [EXE]

1st Display : 2

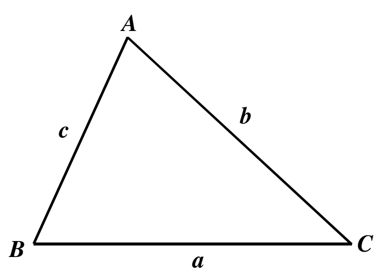
[EXE]

2nd Display : 1 (The set of solution is $x = 2$ and $y = 1$)

Program 3: Cosine Formula

	89 bytes
1	Mem clear : ? → A : ? → B : ? → C : ? → D :
2	D => √(B^2 + C^2 – 2BC cos D → A ◢
3	D = 0 => cos^{-1} ((B^2 + C^2 – A^2) ÷ 2BC → D ◢
4	cos^{-1} ((C^2 + A^2 – B^2) ÷ 2CA ◢
5	π^r – D – Ans ◢ 2^{-1}BC sin D

Case 1: Given 3 sides of a triangle, find the 3 angles and the area of the triangle



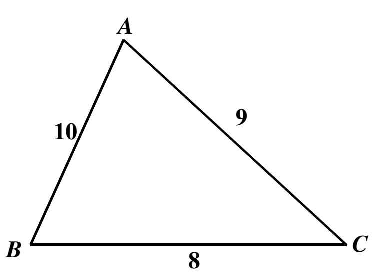
$$\cos\angle A=\frac{b^2+c^2-a^2}{2bc},\quad \cos\angle B=\frac{a^2+c^2-b^2}{2ac},\quad \cos\angle C=\frac{a^2+b^2-c^2}{2ab},$$

$$\text{Area of }\Delta ABC=\sqrt{s(s-a)(s-b)(s-c)},\text{ where } s=\frac{a+b+c}{2}$$

Input: 1st: *a* 2nd: *b* 3rd: *c* 4th: 0 (the input '0' is indicating that 3 sides are given)

Display: 1st: $\angle A$ 2nd: $\angle B$ 3rd: $\angle C$ 4th: Area of ΔABC

Example:



Find $\angle A$, $\angle B$, $\angle C$ and the area of ΔABC.

[Prog] [3]

[8] [EXE] [9] [EXE] [10] [EXE] [0] [EXE]

1st Display: 49.458 ($\angle A = 49.458^\circ$)

[EXE]

2nd Display: 58.752 ($\angle B = 58.752^\circ$)

[EXE]

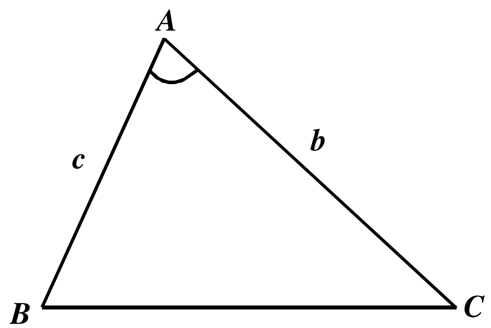
3rd Display: 71.790 ($\angle C = 71.790^\circ$)

[EXE]

4th Display: 34.197 (Area of $\Delta ABC = 34.197$)

Case 2:

Given 2 sides and the included angle of a triangle, find the 3rd side, the remaining angles and the area of the triangle.

	$BC^2 = b^2 + c^2 - 2bc\cos\angle A$ $\dfrac{\sin\angle A}{BC} = \dfrac{\sin\angle B}{b} = \dfrac{\sin\angle C}{c}$ Area of $\Delta ABC = \dfrac{1}{2}bc\sin\angle A$

Input:

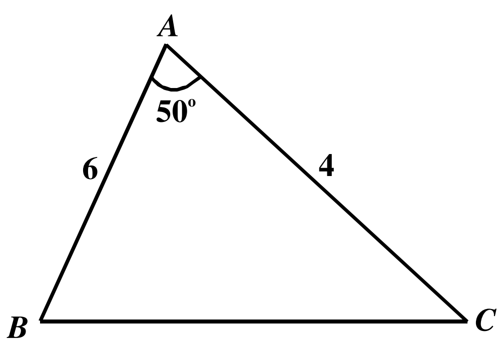
1st: 0 (the input '0' is indicating that one side is NOT given)

2nd: b 3rd: c 4th: $\angle A$

Display:

1st: BC 2nd: $\angle B$ 3rd: $\angle C$ 4th: Area of ΔABC

Example:



Find BC, $\angle B$, $\angle C$ and the area of ΔABC.

[Prog] [3]

[0] [EXE] [4] [EXE] [6] [EXE] [50] [EXE]

1st Display: 4.598 ($BC = 4.598$)

[EXE]

2nd Display: 41.785 ($\angle B = 41.785^\circ$)

[EXE]

3rd Display: 88.215 ($\angle C = 88.215^\circ$)

[EXE]

4th Display: 9.193 (Area of $\Delta ABC = 9.193$)

Program 4: Polynomial Division

	46 bytes
1	Mem clear : ? → A : ? → B : ? → M :
2	Lbl 1 : C : ? → C : (C – B Ans) ┘ A → C :
3	1 M– : M ≧ 0 => Goto 1 : AC

Given a polynomial $f(x) = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0$ and a linear polynomial $g(x) = px + q$,

find the quotient and remainder when $f(x)$ is divided by $g(x)$.

Input	*Display*
1st: p (the coefficient of x of the divisor)	
2nd: q (the constant term of the divisor)	
3rd: n (the degree of the dividend)	
4th: a_n (the coefficient of the term with highest degree in the dividend)	
	1st: b_{n-1} (the coefficient of the term with highest degree in the quotient)
5th: a_{n-1} (the coefficient of the term with second highest degree in the dividend)	
	2nd: b_{n-2} (the coefficient of the term with second highest degree in the quotient)
…………………………………………………………	
	………………………………………………………...
?th: a_1 (the coefficient of x in the dividend)	
	?th: b_0 (the constant term in the quotient)
Final: a_0 (the constant term in the dividend)	
	Final: R (the remainder)

i.e. the Quotient is $b_{n-1}x^{n-1} + b_{n-2}x^{n-2} + \cdots + b_1 x + b_0$ and the Remainder is R

Example:

Find the quotient and remainder when $2x^4 + 3x^3 + 5x^2 + 4x + 6$ is divided by $2x + 1$.

Input		*Display*	
[Prog] [4] [2] [EXE] [1] [EXE] [4] [2]	 (coefficients of divisor) (degree of dividend) (leading coefficient)		
		1	(coefficient of x^3 in the quotient)
[3]	(second coefficient)		
		1	(coefficient of x^2 in the quotient)
[5]			
		2	(coefficient of x in the quotient)
[4]			
		1	(constant term in the quotient)
[6]			
		5	(remainder)

i.e. the quotient is $x^3 + x^2 + 2x + 1$ and the remainder is 5

or $2x^4 + 3x^3 + 5x^2 + 4x + 6 = (2x+1)(x^3 + x^2 + 2x + 1) + 5$