Chapter 10

Program Library

Before using the Program Library

- Be sure to check how many bytes of unused memory are remaining before attempting to perform any programming.
- This Program Library is divided into two sections: a numeric calculation section and a graphics section. Programs in the numeric calculation section produce results only, while graphics programs use the entire display area for graphing. Also note that calculations within graphics programs do not use the multiplication sign (×) wherever it can be dropped (i.e. in front of open parenthesis).

CASIO PROGRAM SHEET

Program for	No.
Prime Factor Analysis	**1**

Description

Produces prime factors of arbitrary positive integers

For $1 < m < 10^{10}$

Prime numbers are produced from the lowest value first. "END" is displayed at the end of the program.

(Overview)

m is divided by 2 and by all successive odd numbers ($d = 3, 5, 7, 9, 11, 13, ...$) to check for divisibility.

Where d is a prime factor, $m_i = m_{i-1}/d$ is assumed, and division is repeated until $\sqrt{m_i} + 1 \leqq d$.

Example

[1]

$119 = 7 \times 17$

[2]

$440730 = 2 \times 3 \times 3 \times 5 \times 59 \times 83$

[3]

$262701 = 3 \times 3 \times 17 \times 17 \times 101$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	M?	11	EXE	83
2	119 EXE	7	12	EXE	END
3	EXE	17	13	EXE	M?
4	EXE	END	14	262701 EXE	3
5	EXE	M?	15	EXE	3
6	440730 EXE	2	16	EXE	17
7	EXE	3	17	EXE	17
8	EXE	3	18	EXE	101
9	EXE	5	19	EXE	END
10	EXE	59	20		

No. **1**

Line	**Program**
File name	P R M F A C T
1	Lbl 0 : " M " ? → A : Goto 2 :
2	Lbl 1 : 2 ◢ A ÷ 2 → A : A = 1 ⇒ Goto 9 :
3	Lbl 2 : Frac (A ÷ 2) = 0 ⇒ Goto 1 : 3 → B :
4	Lbl 3 : √ A + 1 → C :
5	Lbl 4 : B ≥ C ⇒ Goto 8 : Frac (A ÷ B) = 0 ⇒
6	Goto 6 :
7	Lbl 5 : B + 2 → B : Goto 4 :
8	Lbl 6 : A ÷ B × B – A = 0 ⇒ Goto 7 : Goto 5 :
9	Lbl 7 : B ◢ A ÷ B → A : Goto 3 :
10	Lbl 8 : A ◢
11	Lbl 9 : " E N D " ◢ Goto 0
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	

Memory Contents

A	m_i	H		O		V	
B	d	I		P		W	
C	$\sqrt{m_i}+1$	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N		U			

CASIO PROGRAM SHEET

Program for	No.
Greatest Common Measure	**2**

Description

Euclidean general division is used to determine the greatest common measure for two interers a and b.

For $|a|, |b| < 10^9$, positive values are taken as $< 10^{10}$

(Overview)

$n_0 = \max(|a|, |b|)$

$n_1 = \min(|a|, |b|)$

$$n_k = n_{k-2} - \left[\frac{n_{k-2}}{n_{k-1}}\right] n_{k-1}$$

$k = 2, 3....$

If $n_k = 0$, then the greatest common measure (c) will be n_{k-1}.

Example

	[1]	[2]	[3]
When	$a = 238$	$a = 23345$	$a = 522952$
	$b = 374$	$b = 9135$	$b = 3208137866$
	↓	↓	↓
	$c = 34$	$c = 1015$	$c = 998$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	A?	11		
2	238 EXE	B?	12		
3	374 EXE	34	13		
4	EXE	A?	14		
5	23345 EXE	B?	15		
6	9135 EXE	1015	16		
7	EXE	A?	17		
8	522952 EXE	B?	18		
9	3208137866 EXE	998	19		
10			20		

No. **2**

Line	**Program**																		
File name	C	M	N		F	A	C	T											
1	Lbl	1	:	"	A	"	?	→	A	:	"	B	"	?	→	B	:		
2	Abs	A	→	A	:	Abs	B	→	B	:									
3	B	<	A	⇒	Goto	2	:												
4	A	→	C	:	B	→	A	:	C	→	B	:							
5	Lbl	2	:	(–)	(	Int	(	A	÷	B	)	×	B	–	A	)	→	C	:
6	C	=	0	⇒	Goto	3	:												
7	B	→	A	:	C	→	B	:	Goto	2	:								
8	Lbl	3	:	B	◢	Goto	1												
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			

Memory Contents

A	a, n_0	H		O		V	
B	b, n_1	I		P		W	
C	n_k	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N		U			

CASIO PROGRAM SHEET

Program for ***t*-Test Value**	No. **3**

Description

The mean (sample mean) and sample standard deviation can be used to obtain a *t*-test value.

$$t = \frac{(\bar{x} - m)}{\frac{x\sigma_{n-1}}{\sqrt{n}}}$$

$\bar{x}$: mean of x data
$x\sigma_{n-1}$: sample standard deviation of x data
n : number of data items
m : hypothetical population standard deviation (normally represented by μ, but m is used here because of variable name limitations)

Example To determine whether the population standard deviation for sample data 55, 54, 51, 55, 53, 53, 54, 52, is 53.

Perform a *t*-test with a level of significance of 5%.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	M?	3		
2	53 EXE	T= 0.7533708035	4		

The above operation produces a *t*-test value of $t(53) = 0.7533708035$. According to the *t*-distribution table in the next page, a level of significance of 5% and a degree of freedom of 7 ($n - 1 = 8 - 1 = 7$) produce a two-sided *t*-test value of approximately 2.365. Since the calculated *t*-test value is lower than the table value, the hypothesis that population mean m equals 53 is accepted.

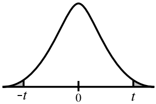
No. **3**

Line	**Program**																		
File name	T		T	E	S	T													
1	{	5	5	,	5	4	,	5	1	,	5	5	,	5	3	,	5	3	,
2	5	4	,	5	2	}	→	List	1	↵									
3	1-Var	List	1	,	1	↵													
4	Lbl	0	:	"	M	"	?	→	M	↵									
5	(	$\bar{x}$	–	M	)	÷	(	$x\sigma_{n-1}$	÷	$\sqrt{\ }$	n	)	→	T	↵				
6	"	T	=	"	:	T	◢												
7	Goto	0																	

Memory Contents							
A		H		O		V	
B		I		P		W	
C		J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M	m	T	t		
G		N		U			

• *t*-distribution table

The values in the top row of the table show the probability (two-sided probability) that the absolute value of t is greater than the table values for a given degree of freedom.



M : ALPHA M

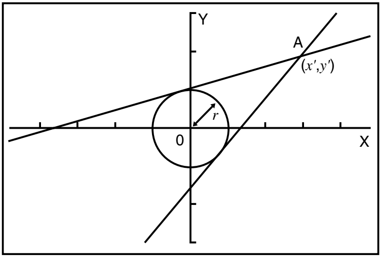
T : ALPHA T

P (Probability) / Degree of Freedom	0.2	0.1	0.05	0.01
1	3.078	6.314	12.706	63.657
2	1.886	2.920	4.303	9.925
3	1.638	2.353	3.182	5.841
4	1.533	2.132	2.776	4.604
5	1.476	2.015	2.571	4.032
6	1.440	1.943	2.447	3.707
7	1.415	1.895	2.365	3.499
8	1.397	1.860	2.306	3.355
9	1.383	1.833	2.262	3.250
10	1.372	1.812	2.228	3.169
15	1.341	1.753	2.131	2.947
20	1.325	1.725	2.086	2.845
25	1.316	1.708	2.060	2.787
30	1.310	1.697	2.042	2.750
35	1.306	1.690	2.030	2.724
40	1.303	1.684	2.021	2.704
45	1.301	1.679	2.014	2.690
50	1.299	1.676	2.009	2.678
60	1.296	1.671	2.000	2.660
80	1.292	1.664	1.990	2.639
120	1.289	1.658	1.980	2.617
240	1.285	1.651	1.970	2.596
∞	1.282	1.645	1.960	2.576

CASIO PROGRAM SHEET

Program for	No.
Circle and Tangents	**4**

Description



Formula for circle:

$$x^2 + y^2 = r^2$$

Formula for tangent line passing through point A (x', y'):

$$y - y' = m\,(x - x')$$

* m represents the slope of the tangent line

With this program, slope m and intercept b $(= y' - mx')$ are obtained for lines drawn from point A (x', y') and are tangent to a circle with a radius of r. The trace function is used to read out the coordinates at the points of tangency, and factor zoom is used to enlarge the graph.

Example

To determine m and b for the following values:

$r = 1$
$x' = 3$
$y' = 2$

Notes

- The point plotted for A cannot be moved. Even if it is moved on the graph, the calculation is performed using the original value.
- An error (Ma ERROR) occurs when $r = x'$.
- Be sure to always perform a trace operation whenever you select trace and the message TRACE is on the display.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

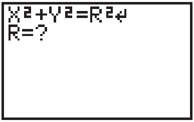
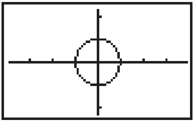
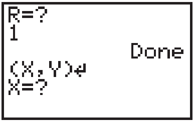
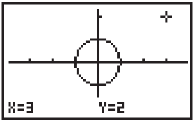
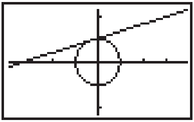
Memory Contents								
	A		H		O		V	
	B		I		P		W	
	C		J		Q		X	
	D		K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

No. **4**

Line	Program																		
File name	T	A	N	G	E	N	T												
1	Prog	"	W	I	N	D	O	W	"	↵									
2	"	X	x^2	+	Y	x^2	=	R	x^2	↵									
3	R	=	"	?	→	R	↵												
4	Prog	"	C	I	R	C	L	E	"	◢									
5	"	(	X	,	Y	)	↵												
6	X	=	"	?	→	A	↵												
7	"	Y	=	"	?	→	B	↵											
8	Plot	A	,	B	◢														
9	R	x^2	(	A	x^2	+	B	x^2	−	R	x^2	)	→	P	↵				
10	(	√	P	−	A	B	)	(	R	x^2	−	A	x^2	)	x^{-1}	→	M	↵	
11	Lbl	6	↵																
12	Graph Y=	M	(	X	−	A	)	+	B	◢									
13	"	M	=	"	:	M	◢												
14	"	B	=	"	:	B	−	M	A	◢									
15	Lbl	0	↵																
16	"	T	R	A	C	E	?	↵											
17	Y	E	S	⇒	1	↵													
18	N	O	⇒	0	"	:	?	→	Z	↵									
19	1	→	S	:	Z	=	1	⇒	Goto	1	↵								
20	Z	=	0	⇒	Goto	2	:	Goto	0	↵									
21	Lbl	2	↵																
22	(	(−)	A	B	−	√	P	)	(	R	x^2	−	A	x^2	)	x^{-1}	→	N	↵
23	Graph Y=	N	(	X	−	A	)	+	B	◢									
24	"	M	=	"	:	N	◢												
25	"	B	=	"	:	B	−	N	A	◢									
26	Lbl	5	↵																
27	"	T	R	A	C	E	?	↵											
28	Y	E	S	⇒	1	↵													
29	N	O	⇒	0	"	:	?	→	Z	↵									
30	2	→	S	:	Z	=	1	⇒	Goto	1	↵								
31	Z	=	0	⇒	Goto	3	:	Goto	5	↵									
32	Lbl	1	↵																
33	"	T	R	A	C	E	"	◢											
34	"	Factor	N	:	N	=	"	?	→	F	:	Factor	F	↵					

No. **4**

Line	Program																	
35	Prog	"	C	I	R	C	L	E	"	:	S	=	1	⇒	Goto	9	↵		
36	S	=	2	⇒	Graph Y=	M	(	X	–	A	)	+	B	↵					
37	Graph Y=	N	(	X	–	A	)	+	B	◢									
38	Goto	3	↵																
39	Lbl	9	↵																
40	Graph Y=	M	(	X	–	A	)	+	B	◢									
41	Prog	"	W	I	N	D	O	W	"	:	Prog	"	C	I	R	C	L	E	"
42	:	Goto	6	↵															
43	Lbl	3	↵																
44	"	E	N	D	"														
File name	W	I	N	D	O	W													
1	View Window	(–)	3	.	9	,	3	.	9	,	1	,	(–)	2	.	3	,	2	.
2	3	,	1																
File name	C	I	R	C	L	E													
1	Graph Y=	√	(	R	x^2	–	X	x^2	)	↵									
2	Graph Y=	(–)	√	(	R	x^2	–	X	x^2	)									

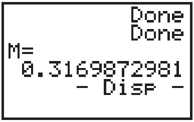
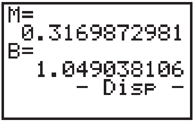
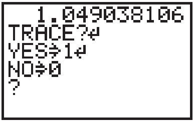
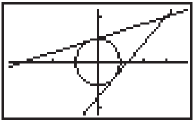
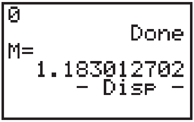
Program for **Circle and Tangents**		No. **4**
Step	**Key Operation**	**Display**
1	F1 (EXE)	 $X^2+Y^2=R^2$↵ R=?
2	1 EXE	
3	EXE	 R=? 1 Done (X,Y)↵ X=?
4	3 EXE 2 EXE	 X=3 Y=2
5	EXE	

Program for

Circle and Tangents

No.

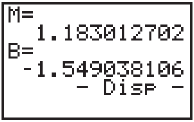
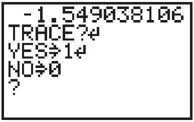
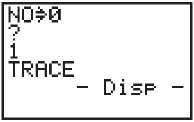
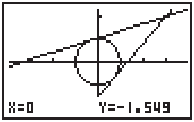
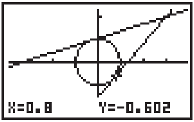
4

Step	Key Operation	Display
6	EXE	 Done Done M= 0.3169872981 - Disp -
7	EXE	 M= 0.3169872981 B= 1.049038106 - Disp -
8	EXE	 1.049038106 TRACE?↵ YES⇒1↵ NO⇒0 ?
9	0 EXE	
10	EXE	 0 Done M= 1.183012702 - Disp -

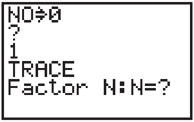
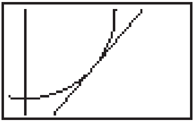
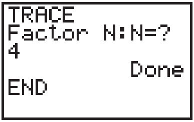
Program for

Circle and Tangents

No. **4**

Step	Key Operation	Display
11	EXE	 M= 1.183012702 B= -1.549038106 - Disp -
12	EXE	 -1.549038106 TRACE?↵ YES⇒1↵ NO⇒0 ?
13	1 EXE	 NO⇒0 ? 1 TRACE - Disp -
14	SHIFT F1 (TRC)	 X=0 Y=-1.549
15	▶ ~ ▶	 X=0.8 Y=-0.602

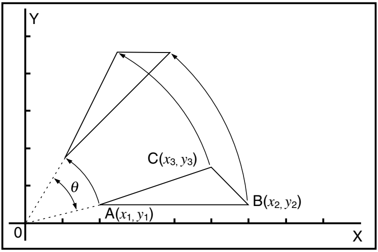
Program for **Circle and Tangents**	No. **4**

Step	Key Operation	Display
16	EXE	 NO⇒0 ? 1 TRACE Factor N:N=?
17	4 EXE	
18	EXE	 TRACE Factor N:N=? 4 Done END

CASIO PROGRAM SHEET

Program for	No.
Rotating a Figure	**5**

Description



Graphing of rotation of any geometric figure by θ degrees.

Formula for coordinate transformation:

$$(x, y) \rightarrow (x', y')$$

$$x' = x \cos \theta - y \sin \theta$$

$$y' = x \sin \theta + y \cos \theta$$

Example

To rotate by 30° the triangle defined by points A (2, 0.5), B (6, 0.5), and C (5, 1.5)

Notes

- Use the cursor keys to move the pointer around the display.
- To interrupt program execution, press AC while the graphic screen is on the display.
- The triangle cannot be drawn if the result of the coordinate transformation operation exceeds View Window parameters.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Memory Contents	A	x_1	H	y'_1	O		V	
	B	y_1	I	x'_2	P		W	
	C	x_2	J	y'_2	Q	θ	X	
	D	y_2	K	x'_3	R		Y	
	E	x_3	L	y'_3	S		Z	
	F	y_3	M		T			
	G	x'_1	N		U			

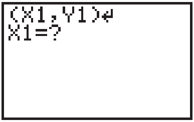
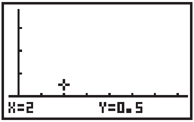
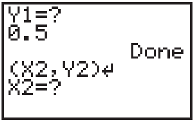
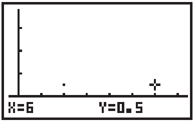
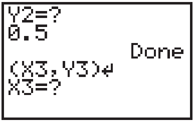
No. **5**

Line	Program																		
File name	R	O	T	A	T	E													
1	View Window	(–)	0	.	4	,	7	.	4	,	1	,	(–)	0	.	8	,	3	.
2	8	,	1	:	Deg	↵													
3	"	(	X	1	,	Y	1	)	↵										
4	X	1	=	"	?	→	A	↵											
5	"	Y	1	=	"	?	→	B	↵										
6	Plot	A	,	B	◢														
7	X	→	A	:	Y	→	B	↵											
8	"	(	X	2	,	Y	2	)	↵										
9	X	2	=	"	?	→	C	↵											
10	"	Y	2	=	"	?	→	D	↵										
11	Plot	C	,	D	◢														
12	X	→	C	:	Y	→	D	↵											
13	"	(	X	3	,	Y	3	)	↵										
14	X	3	=	"	?	→	E	↵											
15	"	Y	3	=	"	?	→	F	↵										
16	Plot	E	,	F	◢														
17	X	→	E	:	Y	→	F	↵											
18	Lbl	1	↵																
19	Line	:	Plot	A	,	B	:	Line	:	Plot	C	,	D	:	Line	◢			
20	"	A	N	G	L	E	:	Deg	"	?	→	Q	↵						
21	A	cos	Q	–	B	sin	Q	→	G	↵									
22	A	sin	Q	+	B	cos	Q	→	H	↵									
23	Plot	G	,	H	↵														
24	C	cos	Q	–	D	sin	Q	→	I	↵									
25	C	sin	Q	+	D	cos	Q	→	J	↵									
26	Plot	I	,	J	:	Line	↵												
27	E	cos	Q	–	F	sin	Q	→	K	↵									
28	E	sin	Q	+	F	cos	Q	→	L	↵									
29	Plot	K	,	L	:	Line	↵												
30	Plot	G	,	H	:	Line	◢												
31	Cls	:	Plot	C	,	D	:	Plot	E	,	F	:	Goto	1					
32																			
33																			
34																			

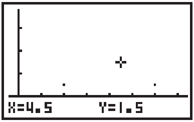
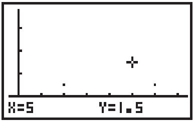
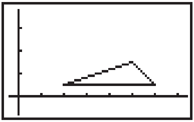
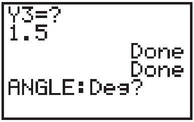
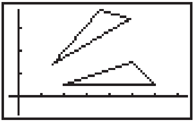
Program for

Rotating a Figure

No. **5**

Step	Key Operation	Display
1	F1 (EXE)	 (X1,Y1)↵ X1=?
2	2 EXE 0.5 EXE	 X=2 Y=0.5
3	EXE	 Y1=? 0.5 Done (X2,Y2)↵ X2=?
4	6 EXE 0.5 EXE	 X=6 Y=0.5
5	EXE	 Y2=? 0.5 Done (X3,Y3)↵ X3=?

Program for **Rotating a Figure**	No. **5**

Step	Key Operation	Display
6	4.5 EXE 1.5 EXE	 X=4.5 Y=1.5
7	▶ ~ ▶ (Locate the pointer at X = 5)	 X=5 Y=1.5
8	EXE	
9	EXE	 Y3=? 1.5 Done Done ANGLE:Deg?
10	30 EXE	

Continue, repeating from step 8.