EVALUATING EXPRESSIONS
(Finding the output, given an input value)

Q: According to the **Toys R Us** *1995 annual report*, the number of stores between the years 1984 and 1994 can be modeled by the following equation:

$$y = 2x^2 + 56x - 53$$ stores, where x is the number of years after 1980.

Use this model to estimate the number of stores in 1985 and in 1993.

This handout will teach three methods of evaluating the right hand side of an equation (an expression) for a given value of x. The methods will include arithmetic, tables, graphs, and function notation on the TI-85 graphing calculator.

To answer the previous questions, first let x = 5 for 1985 (5 years after 1980) and x = 13 for 1993. These will be the input values used to find the corresponding number of stores in each year (the output values).

METHOD #1: Arithmetic on the graphing calculator

1. Using x = 5, type the numerical expression (the right hand side of the equation) onto the home screen. Hit **ENTER** to evaluate.

   There were 277 stores in 1985.

```
2(5)²+56(5)−53
                        277
■
```

2. To answer the second question, let X = 13. Instead of retyping the entire expression, hit **2nd ENTER** and the last expression will appear again. Use the arrow keys to backspace and replace each 5 with a 13, then hit **ENTER** to reevaluate. (Use the insert key: INS – above DEL, for the 13.)
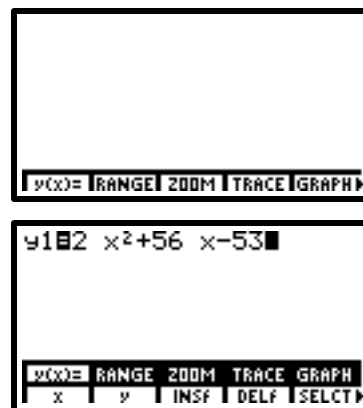
   There were 1013 stores in 1993.

```
2(5)²+56(5)−53
                        277
2(5)²+56(5)−53■
```

```
2(5)²+56(5)−53
                        277
2(13)²+56(13)−53
                        1013
■
```

For the remaining methods, the equation will need to be typed into the "Y= " screen as follows:
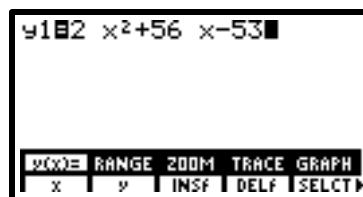
1. Hit **GRAPH**.

2. Choose "**y(x)=**" (using the function keys at the top) and type the equation into y1. (To get rid of the menu on the bottom when you are finished, hit **EXIT** twice.)
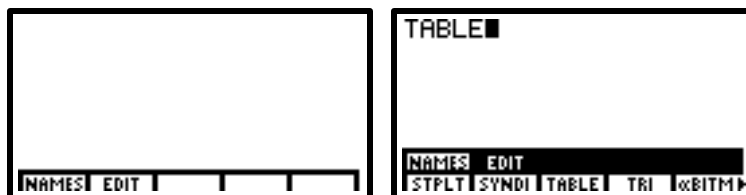
```
┌────────────────────────────────────┐
│                                    │
│                                    │
│                                    │
│                                    │
│                                    │
│ y(x)= RANGE ZOOM TRACE GRAPH▶      │
├────────────────────────────────────┤
│ y1■2 x²+56 x−53■                   │
│                                    │
│                                    │
│                                    │
│                                    │
│ y(x)= RANGE ZOOM TRACE GRAPH       │
│   x  │  y  │ INSf │ DELf │SELCT▶   │
└────────────────────────────────────┘
```

METHOD #2: Using a table on the graphing calculator

The TI-85 is capable of showing a table of values for the equation(s) stored in the "Y=" screen when using a program called TABLE. The table can be set to begin at any value of x. Because the first x value to be evaluated in the problem is x = 5, set the table to begin there (TblMin). The table must also be set for a distance between x values. Since x represents the number of years after 1980 it would make sense to let the distance between x values be 1 (DTblMin).

1. Make sure the equation is typed into y1. Hit **GRAPH**, then choose "**y(x)=**" and type in the equation. (It was already typed in for this problem.) Hit **EXIT** twice.

```
┌────────────────────────────────────┐
│ y1■2 x²+56 x−53■                   │
│                                    │
│                                    │
│                                    │
│ y(x)= RANGE ZOOM TRACE GRAPH       │
│   x  │  y  │ INSf │ DELf │SELCT▶   │
└────────────────────────────────────┘
```

2. To run the program hit **PRGM**, then choose **NAMES**. Choose the program named **TABLE**. (You may have to hit **MORE** to find it.) Hit **ENTER**.
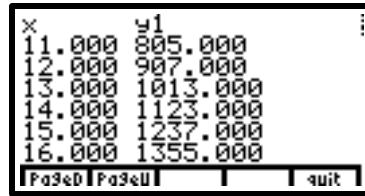
```
┌────────────────────┐  ┌────────────────────┐
│                    │  │ TABLE■             │
│                    │  │                    │
│                    │  │                    │
│                    │  │                    │
│                    │  │ NAMES  EDIT        │
│ NAMES  EDIT        │  │STPLT SYNDI TABLE TRI ×BITM▶│
└────────────────────┘  └────────────────────┘
```

3. Set TblMin to be **5**. Hit **ENTER**. Set DtblMin to be **1**. Hit **ENTER**.

   There were 277 stores in 1985.

```
┌────────────────────┐  ┌────────────────────┐
│ TABLE              │  │ TABLE              │
│ Table setup        │  │ Table setup        │
│ TbiMin=5           │  │ TbiMin=5           │
│                    │  │ DTblMin=1          │
│                    │  │                    │
│                    │  │                    │
└────────────────────┘  └────────────────────┘
```

```
┌────────────────────┐
│ x        y1        │
│ 5.000    277.000   │
│ 6.000    355.000   │
│ 7.000    437.000   │
│ 8.000    523.000   │
│ 9.000    613.000   │
│ 10.000   707.000   │
│ PageD PageU    quit│
└────────────────────┘
```

4. To answer the second question,
    scroll down the table using the
    PageD option,until the x value
    of 13 can be seen in the window.

    There were 1013 stores in 1993

5. Choose **quit** to exit the program.

```
x          y1                    ┊
11.000  805.000
12.000  907.000
13.000  1013.000
14.000  1123.000
15.000  1237.000
16.000  1355.000
 PageD PageU            quit
```

METHOD #3: Using a graph on the graphing calculator

The TI-85 is capable of using a graph of an equation stored in the "Y=" screen to find the output value for any input value within a given window. The first thing to do is to set up the viewing window. ***To use the "EVAL" feature, the input values to be used <u>must</u> be within the window.*** Set the x values of the window to be between 0 and 15 (xMin and xMax), to include x = 5 and x = 13. xScl is used to show tick marks on the x-axis; set this value to be 5, to show a tick mark every 5 units.

The y values on this graph represent the number of stores in a given year. An idea of the output values must be known to be able to set them. Set the y values of the window to be between 0 and 1200 (yMin and yMax), and the yScl to be 100.
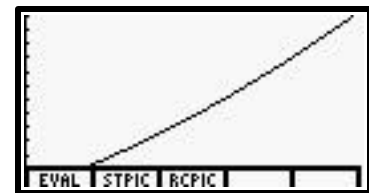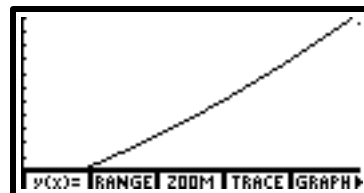
1. Make sure the equation is typed into y1. Hit **GRAPH**, then choose "**y(x)=**" and type in the equation. (It was already typed in for this problem.) Hit **EXIT** <u>once</u>.

y1■2 x²+56 x-53■

y(x)= RANGE ZOOM TRACE GRAPH
   x   y   INSf DELf SELCT►
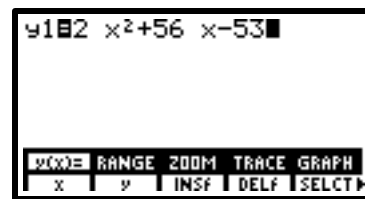
2. Set the window by choosing **RANGE**. Use the values in the screen to the right (notice 5 and 13 are contained in the range of X values).

RANGE
 xMin=0
 xMax=15
 xScl=5
 yMin=0
 yMax=1200
 yScl=100
y(x)= RANGE ZOOM TRACE GRAPH►
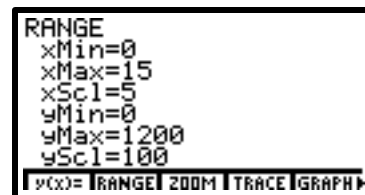
3. To view the graph choose **GRAPH**.

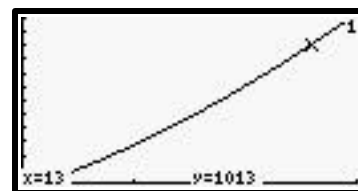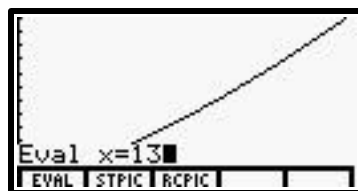y(x)= RANGE ZOOM TRACE GRAPH►   EVAL STPIC RCPIC

4. To find the output value at x=5, hit **MORE** twice and then choose **EVAL**. Type in a **5** after "Eval x=". Hit **ENTER**.

   There were 277 stores in 1985.

Eval x=5■
EVAL STPIC RCPIC   x=5 _____ y=277 _____
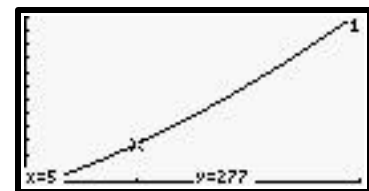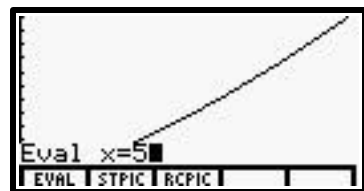
5. Follow the same steps for x = 13.

Eval x=13■
EVAL STPIC RCPIC   x=13 _____ y=1013 _____

   There were 1013 stores in 1993.

METHOD #4: Using function notation on the graphing calculator

The TI-85 is capable of recognizing (a form of) function notation. To use this feature, an equation must be stored into the "Y=" screen and an input value must be stored in the variable x. The TI-85 will evaluate the function only at a stored value of x. The name of the function will be the location the equation is stored in (i.e. y1). The TI-85 will **not** recognize the notation y1(5) or y1(13).

Find y1at x =5 and y1 at x = 13 as follows:

1. Make sure the equation is typed into y1. Hit **GRAPH**, then choose "**y(x)=**" and type in the equation. (It was already typed in for this problem.) Hit **EXIT** <u>twice</u> to get back to the HOME screen.

```
y1■2 x²+56 x-53■



[XXXX] RANGE ZOOM TRACE GRAPH
  x  │  y  │ INSf │ DELf │SELCT▶
```
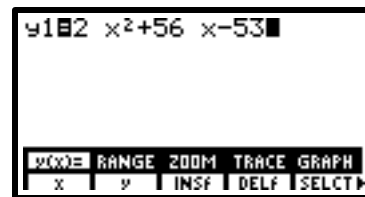
2. The process MUST be started from the HOME screen. Store 5 into x by hitting "**5**" then **STO▷** , and then "**x**".   Hit **ENTER**.

```
5→x
                    5
■
```

3. Get the variable name y1 by hitting **2ⁿᵈ Alpha Y** then hit "**1**". To evaluate y1 at x = 5 hit **ENTER**.

    There were 277 stores in 1985.

```
5→x
                    5
y1
                  277
■
```

4. To answer the second question, Store 13 into x and then re-evaluate y1.

    There were 1013 stores in 1993.

```
13→x
                   13
y1
                 1013
```