

# Graphical designs

## Student Worksheet

7 8 9 10 11 12



TI-Nspire



Investigation



Student



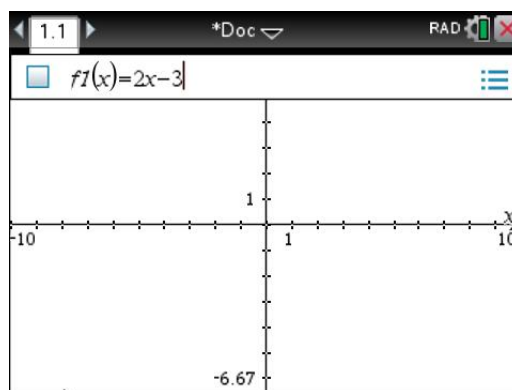
90 min

## Introduction

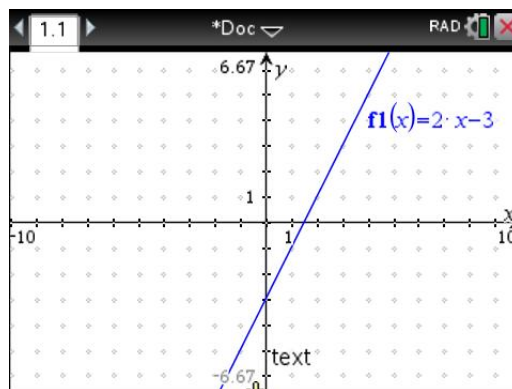
Function graphs can be used to create various designs. In this task you will be challenged to reproduce designs using your knowledge of linear and quadratic functions and their graphs. We will start by reviewing the plotting of linear function graphs on the TI-Nspire CAS, using the linear function with rule  $y = 2x - 3$ .

On the TI-Nspire CAS

- Press **HOME-1** to create a new document, and then press **2** to add a **Graphs** page.
- Type the rule **f1(x) = 2x - 3** and then press **ENTER**.
- Press **MENU-2-6** to select **View** and then press **2** (Dot Grid).



The graph should appear as shown at right. (Note the function label has been retained in this case.) The end values of the axes show that the function is graphed in the window with dimensions  $[-10, 10]$  by  $[-6.67, 6.67]$ , which is the window we will use for this exploration. This window has the advantage that it uses the same scale on both the  $x$ - and the  $y$ -axes.



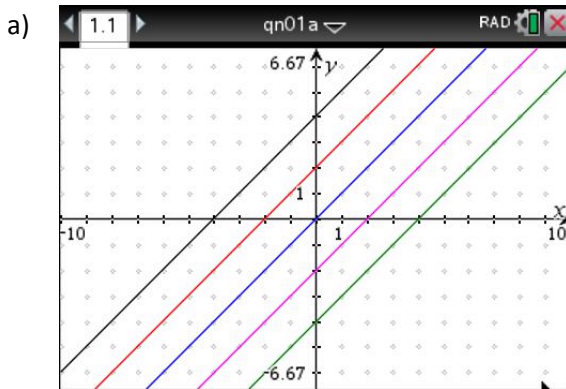
## Part 1: Designs with lines

A linear function has rule of the form  $y = ax + b$ . In the example above, we chose  $a = 2$  and  $b = -3$ . Try various values of  $a$  and  $b$  to generate the following designs.

### Question 1.

Use your knowledge of linear function graphs to construct the following designs in the standard window shown. (Press **MENU-4** to select **Window** and then press **5** to select **Zoom – Standard**.) When you have successfully completed each design, record the function rules that you have used.

[Note: To edit an existing rule or to enter additional rules, press either **TAB** or **CTRL-G**. This will display the function rule editing line at the top of the page. After each design has been completed, you can delete all the graphs in one step by pressing **MENU-1-6**.]



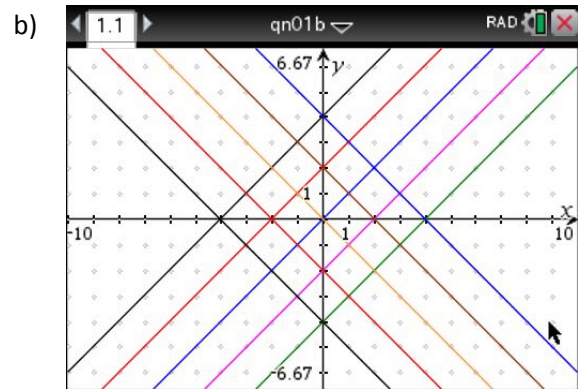
$y =$  \_\_\_\_\_

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$y =$  \_\_\_\_\_



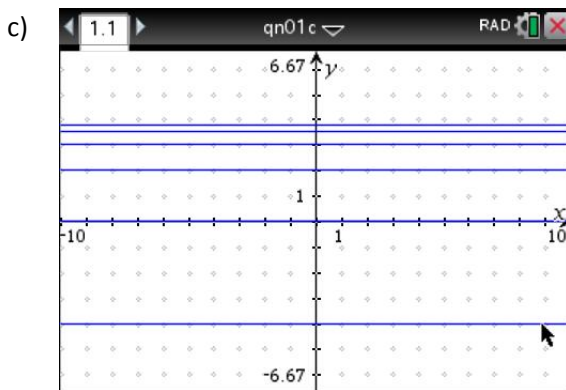
$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

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$y =$  \_\_\_\_\_



$y =$  \_\_\_\_\_

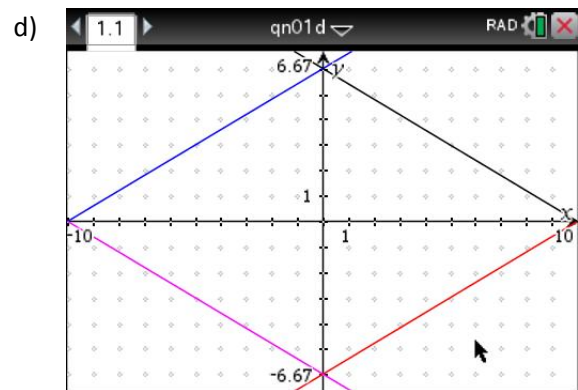
$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

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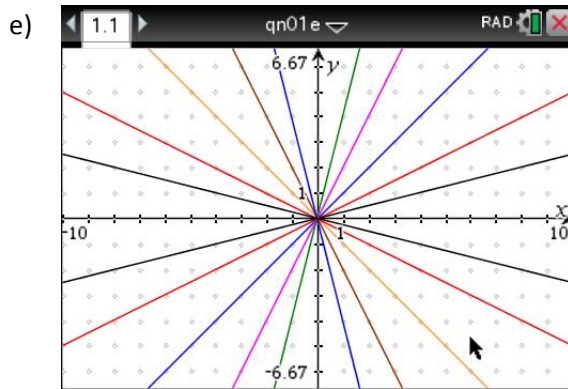


$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_



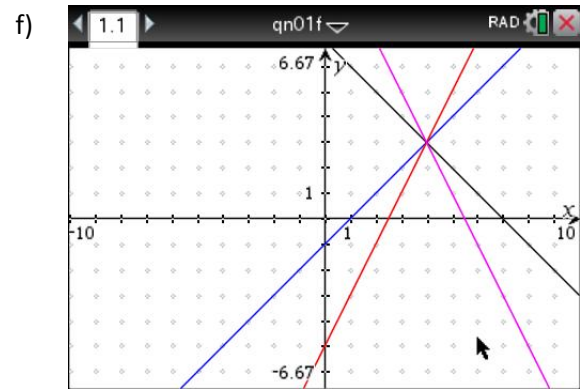
$y =$  \_\_\_\_\_ and \_\_\_\_\_

$y =$  \_\_\_\_\_ and \_\_\_\_\_

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$y =$  \_\_\_\_\_ and \_\_\_\_\_



$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

### Question 2.

Summarise what you have discovered about the effect of the values of  $a$  and  $b$  on the graph of linear function with rule  $y = ax + b$ .

a) Effect of  $a$

b) Effect of  $b$

### Question 3.

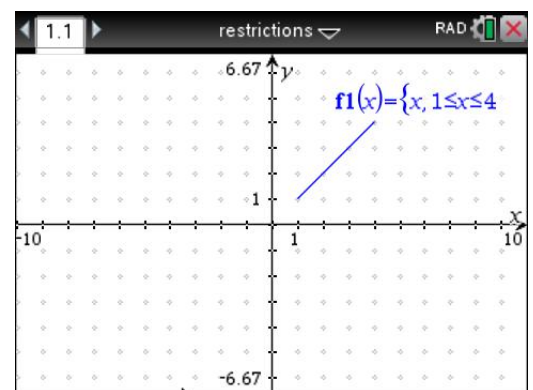
Use the graphs of linear functions to create your own designs.

## Part 2: Line designs with restrictions

It is possible to graph only a part of a linear function by restricting the  $x$ -values to which the function applies. This is called 'restricting the domain' of a function. For example, using the TI-Nspire CAS, the graph of  $y = x$  can be drawn for  $1 \leq x \leq 4$ , by using the following syntax (*ignore spaces*):

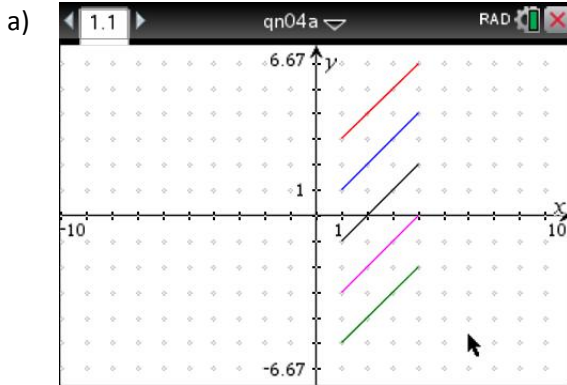
$$f1(x) = x | 1 \leq x \leq 4$$

Note that the key for the symbol " $|$ " can be found by pressing CTRL and then " $=$ ". Observe that only a segment of the graph has been drawn (see right).

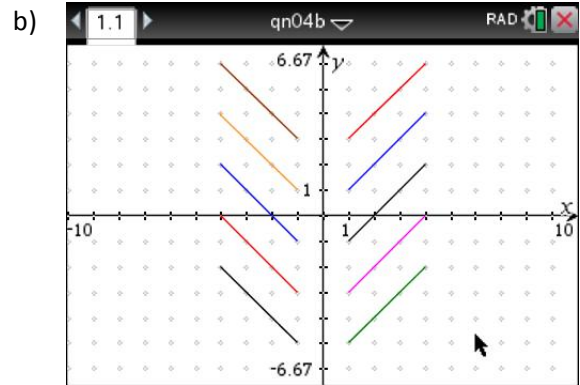


**Question 4.**

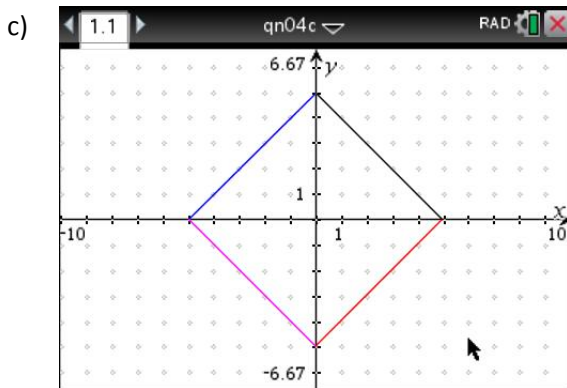
Use this syntax and your knowledge of linear function graphs to construct the following designs in the standard window. (Press **MENU-4** to select **Window** and then press **5** to select **Zoom – Standard**). Show the rules used (including any domain restrictions).



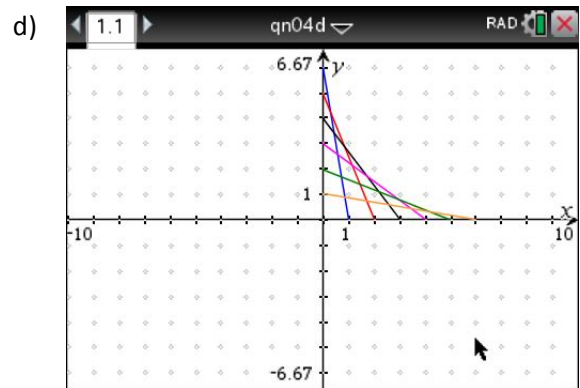
y = \_\_\_\_\_  
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y = \_\_\_\_\_ and \_\_\_\_\_  
 y = \_\_\_\_\_ and \_\_\_\_\_  
 y = \_\_\_\_\_ and \_\_\_\_\_  
 y = \_\_\_\_\_ and \_\_\_\_\_  
 y = \_\_\_\_\_ and \_\_\_\_\_



y = \_\_\_\_\_  
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y = \_\_\_\_\_  
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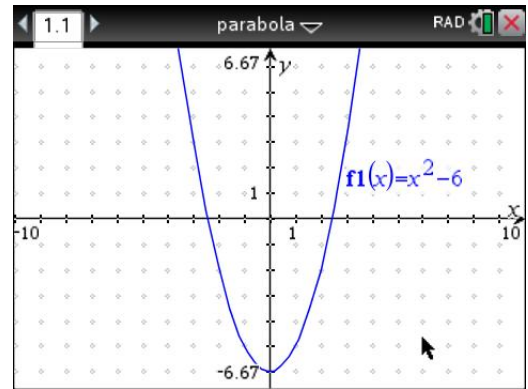
**Extension:** Use the graphs of linear functions with restrictions to come up with your own design. Use domain restrictions if you wish.

### Part 3: Parabola designs

It is of course possible to create designs using other function types, such as the graphs of quadratic functions (called parabolas). Quadratic functions have the forms listed below. Each is useful for determining some aspect of its graph, such as its axes intercepts and the turning point of the parabola.

- Expanded form:  $y = ax^2 + bx + c$
- Factorised form:  $y = a(x - d)(x - e)$
- Turning point form:  $y = a(x - h)^2 + k$

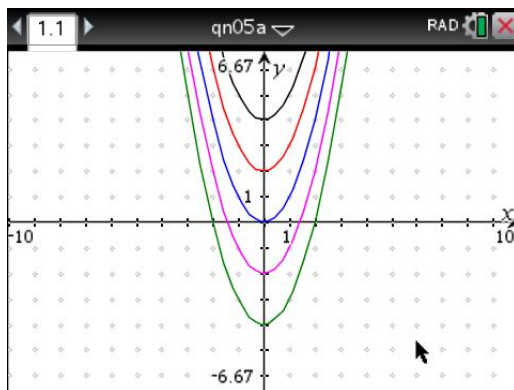
For instance, in the example shown, the expanded form has been used with  $a = 1$ ,  $b = 0$  and  $c = -6$ .



#### Question 5.

Use your knowledge of quadratic function graphs to construct the following designs in the windows shown. In this question, use the expanded form of the rule ( $y = ax^2 + bx + c$ ). When you have successfully completed each design, record the function rules you have used.

a)



$y =$  \_\_\_\_\_

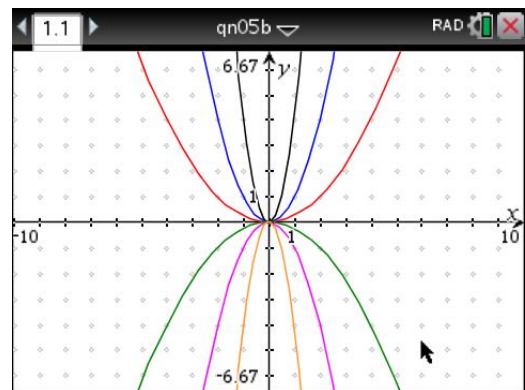
$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

b)



$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

$y =$  \_\_\_\_\_

#### Question 6.

Summarise what you have discovered about the effect of the value of  $a$  and  $c$  on the graph of quadratic function with rule  $y = ax^2 + c$ .

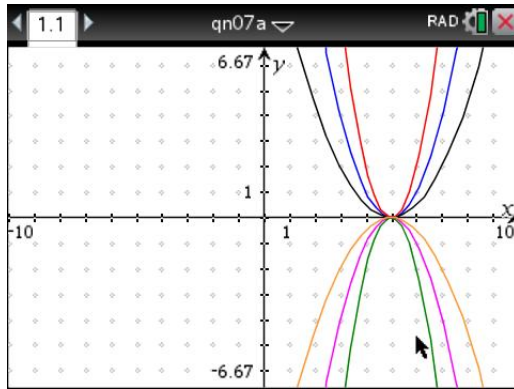
a) Effect of  $a$

b) Effect of  $c$

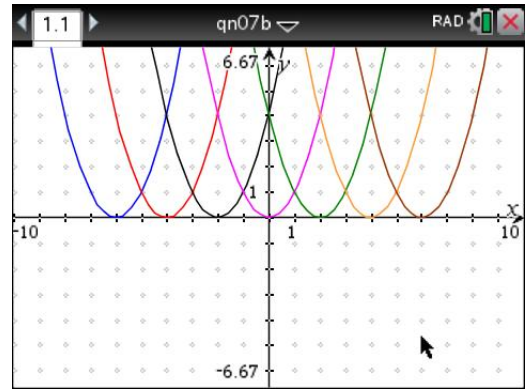
**Question 7.**

Use your knowledge of quadratic function graphs to construct the following designs in the windows shown. In this question, use either the factorised form of the rule ( $y = a(x - d)(x - e)$ ) or the turning point form ( $y = a(x - h)^2 + k$ ). When you have successfully completed each design, record the function rules you have used.

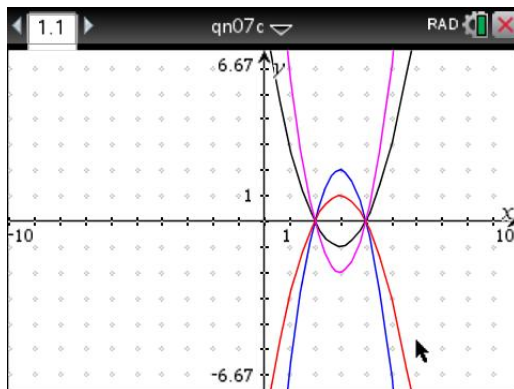
a)

 $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_

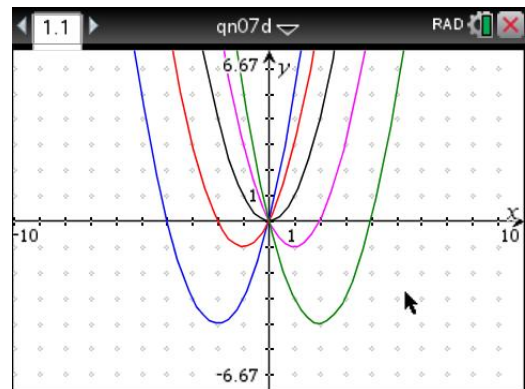
b)

 $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_

c)

 $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_

d)

 $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_ $y =$  \_\_\_\_\_

**Question 8.**

Summarise what you have discovered about the effect of the value of  $a$ ,  $b$  and  $c$  on the graph of linear function with rule  $y = a(x - d)(x - e)$ .

a) Effect of  $a$

b) Effect of  $d$  and  $e$

**Challenge: Make the Big M sign!**

In order to do this, you will need to use what you learned in the previous explorations, including how to incorporate domain restrictions. (Note, to hide the coordinate axes, press **MENU-2-5**.) When you have succeeded in making this shape, record the two function rules you used, including the domain restriction.

