# Linear Alchemy

Teachers Teaching with Technology™
Professional Development from Texas Instruments

## Student Activity

7 8 **9** 10 11 12

TI-Nspire™ | Investigation | Student | 50 min

## Calculator Instructions: Linear Factors

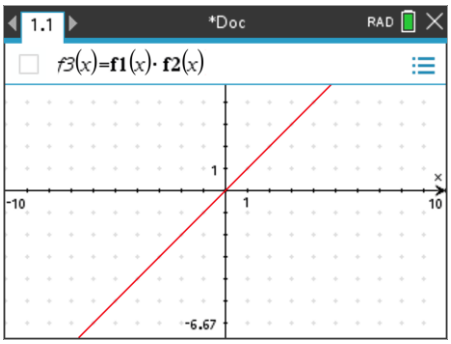
Create a new TI-Nspire file and insert a Graphs application.

Navigate to the equation entry line and enter the following functions:

$$f_1(x) = x$$

$$f_2(x) = x$$

$$f_3(x) = f_1(x)\, f_2(x)$$



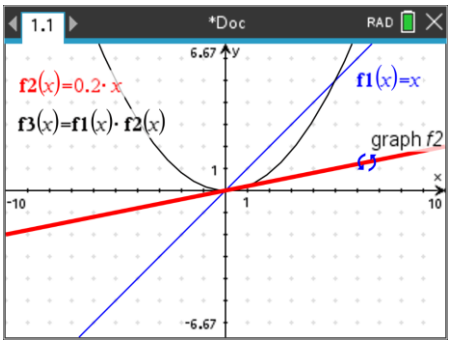

**Note**: The graph of $f_3(x)$ is not shown opposite.

Graph 1 and 2 are directly on top of one another which is why you will only see one graph, rest assured, the second graph is there.

### Question: 1.

Explain the shape of Graph $f_3(x)$.

Place the mouse over graph $f_2(x)$ and rotate the graph around the origin.




When multiple objects are in one area, a tool tip will be displayed. The 'tip' should state "graph f2". You can use the TAB key to toggle between the different layers.

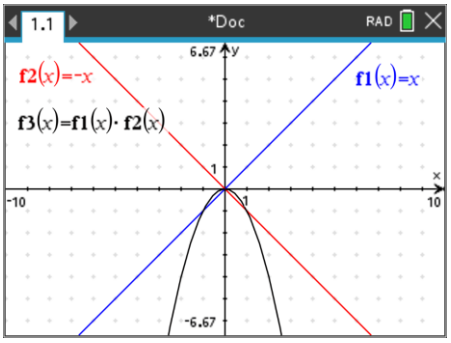
### Question: 2.

In the screen show opposite:

$$f_1(x) = x$$

$$f_2(x) = -x$$

What is the equation for $f_3(x)$?



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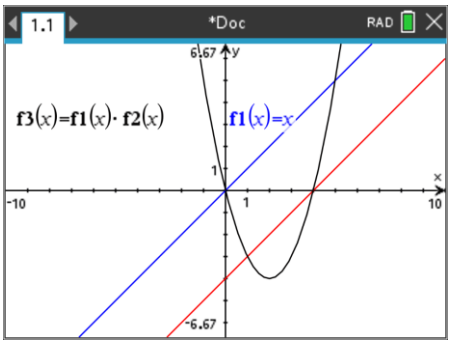
Place the mouse over $f_2(x)$ and rotate the graph to its original position.

The graph of $f_2(x)$ needs to be translated as shown opposite, the x and y axes intercepts are both integer values.

Translations can be performed by grabbing a point close to the centre of the graph. The mouse will appear as a double arrow: ✣ alternatively, double click on the relevant graph and type the equation directly.




You can use ctrl + Z to "undo" previous transformations and ctrl + Y to "re-do" them.

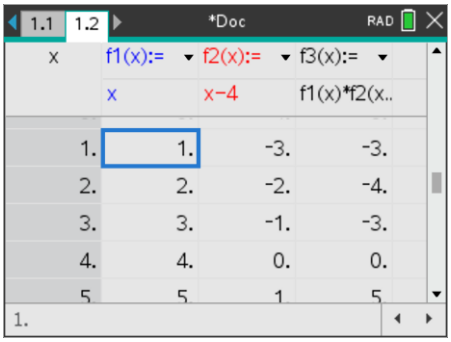
**Question: 3.**

In the calculator screen shot above, given that: $f_1(x) = x$ what are the equations for $f_2(x)$ and $f_3(x)$?

Press ctrl + T to generate a table of values for all three graphs.

You can also press ctrl + 6 to ungroup the Graph application from the table, this will shift the table to the next page.

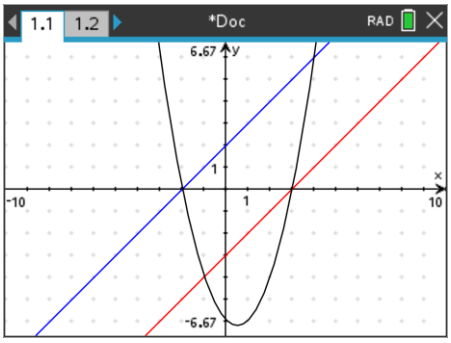
Use the arrow keys to navigate up / down / left / right through the table.




**Question: 4.**

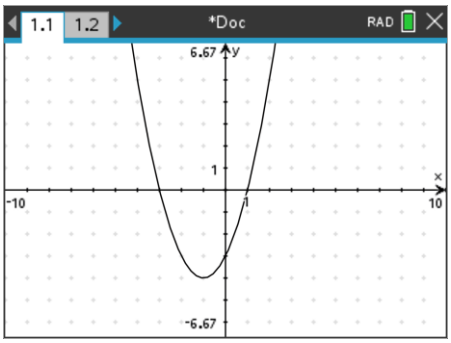
With reference to the table, what do you notice about the $x$ axis intercepts for $f_1(x)$, $f_2(x)$ and $f_3(x)$?

In the graph shown opposite, given $f_2(x) = x - 3$, determine possible equations for $f_1(x)$ and $f_3(x)$ given they have integer axes intercepts.




**Question: 5.**

In the graph shown opposite $f_1(x)$ and $f_2(x)$ have been hidden, suggest a possible function for each given $f_3(x)$.



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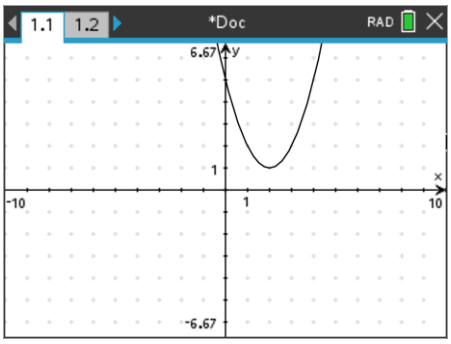
**Question: 6.**

Explain why $f_3(x)$ cannot be formed by two linear factors.



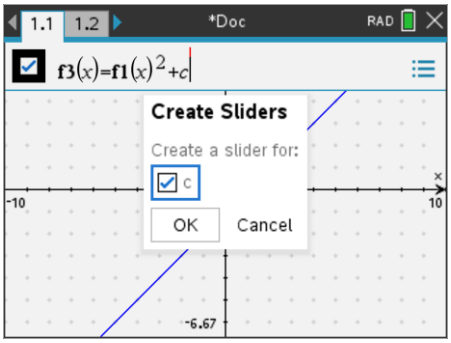

Think about numbers that have factors (composite) and numbers that don't (prime). Just like prime numbers, we cannot express the graph in Question 7 as the product of two linear factors. A prime number (p) however could be expressed as a composite number (n) squared plus some constant (c).

Example: $29 = 5^2 + 4$.

We can do the same for the graph in Question 7.

Re-write $f_3(x)$ as shown opposite:

$$f_3(x) = f_1(x)^2 + c$$

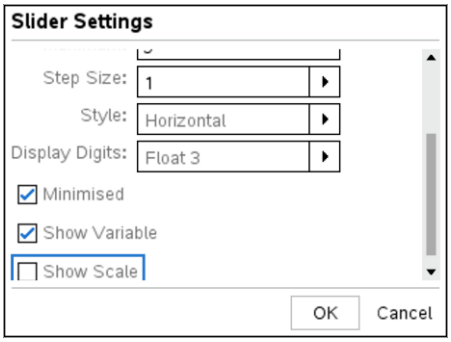



As 'c' is not defined you will be prompted to add a slider.

In this section we are not using $f_2(x)$ so it can be hidden or deleted.

The default version of the slider can be changed to a 'toggle' by minimising. Move the mouse over the top of the slider and press:

ctrl + menu




Change the following:

Minimised = checked

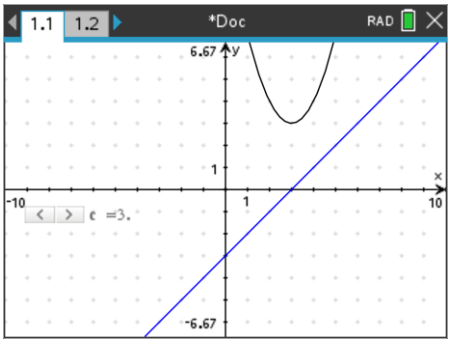
Step size = 1

Show Scale = unchecked

Experiment with the following:

- Rotate the linear function
- Translate the linear function
- Increase and decrease the slider value (c)

For each 'experiment', observe closely what is happening with the parabola.



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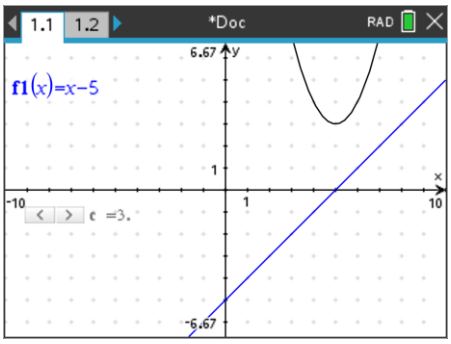
**Question: 7.**

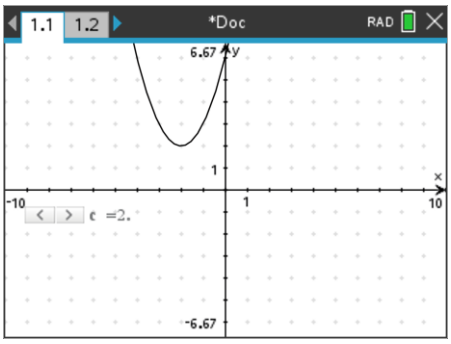
The linear function: $f_1(x) = x - 5$ and the constant (slider) are used to generate the graph of $f_3(x)$ such that: $f_3(x) = f_1(x)^2 + c$.

Determine the equation for $f_3(x)$.




**Question: 8.**

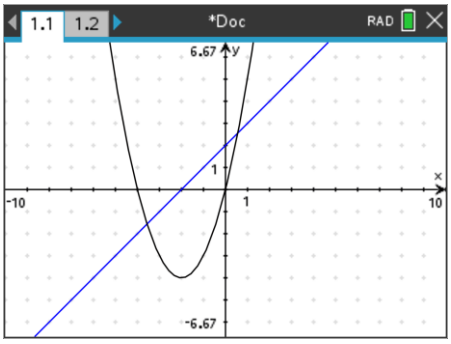
In the screen shot shown opposite, the graph of $f_1(x)$ has been hidden. Suggest a possible equation for $f_3(x)$




**Question: 9.**

In the screen shot shown opposite, the slider has been hidden.

Suggest two possible equations for $f_3(x)$



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