## Lesson 7: Expressing Transformations of Functions Algebraically

* Let’s express transformed functions algebraically.

### 7.1: Describing Translations

Let . Complete the table. Be prepared to explain your reasoning.

|  |  |  |
| --- | --- | --- |
| words (the graph of is...) | function notation | expression |
| translated left 5 units |  |  |
| translated left 5 units and down 3 units |  |  |
|  |  |  |
| translated left 5 units, then down 3 units, then reflected across the -axis |  |  |

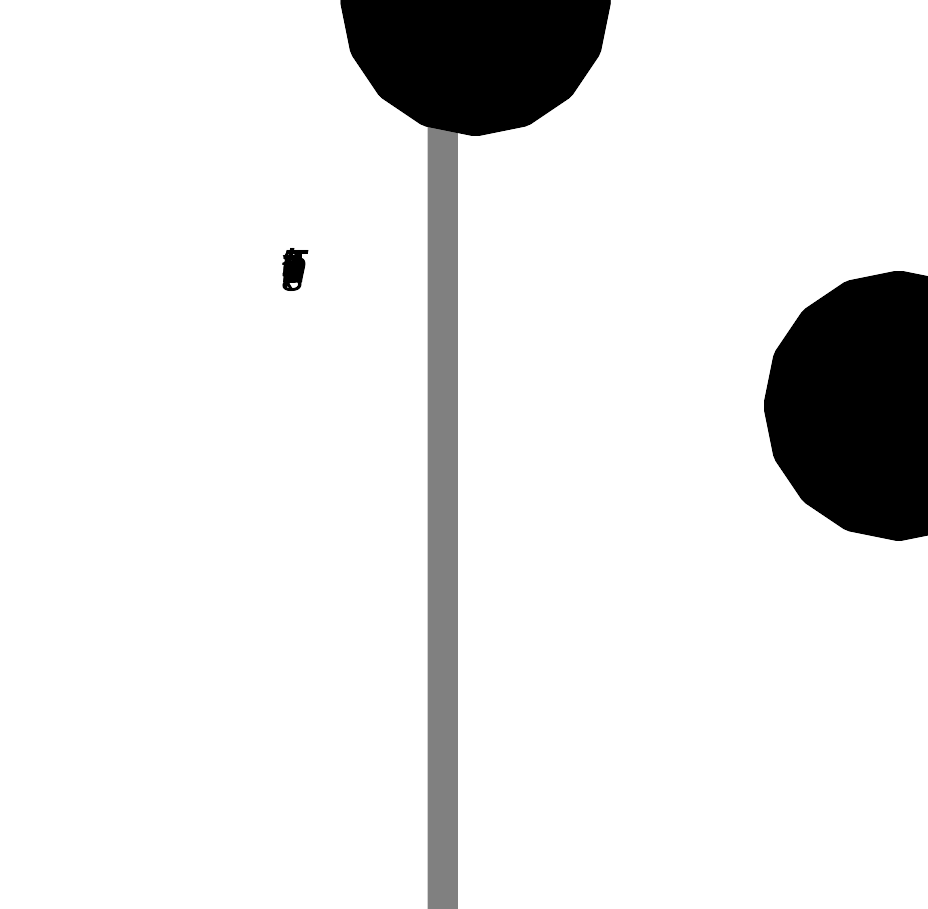
### 7.2: Translating Vertex Form

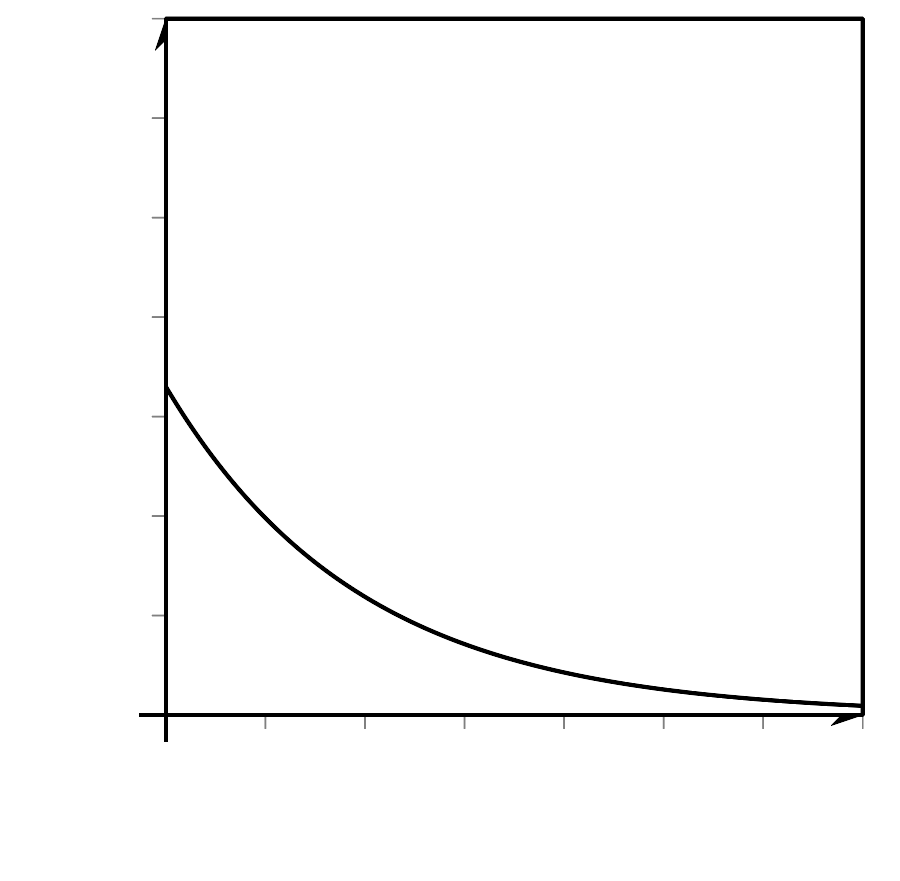
Let be the function given by .

1. Write an equation for the function whose graph is the graph of translated 3 units left and up 5 units.
2. What is the vertex of the graph of ? Explain how you know.
3. Write an equation for a quadratic function whose graph has a vertex at .
4. Write an equation for a quadratic function whose graph opens downward and has a vertex at .

### 7.3: An Even Better Fit

In an earlier lesson, we looked at the temperature , in degrees Fahrenheit, of a bottle of soda water left outside for hours. Let’s model this data with a function. This time, we will start with the function . This graph has a shape that fits the data well.





1. Describe a translation of this graph that fits the data.
2. Write an equation defining a function that models the data.
3. What does your function tell you about the temperature outside?

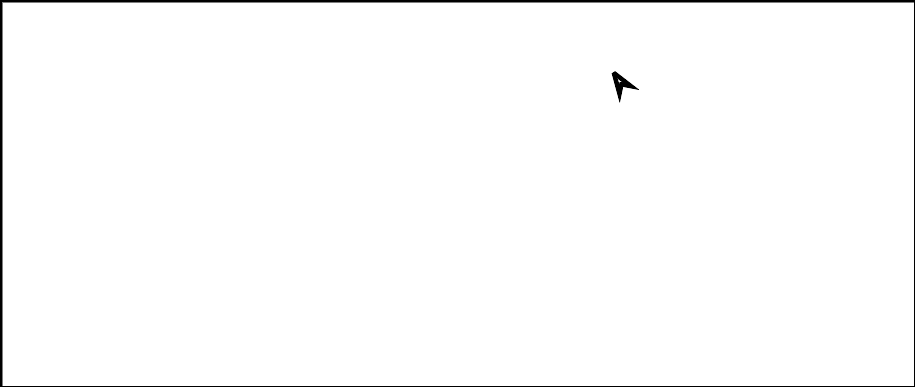
#### Are you ready for more?

Han tried the following steps to model the soda water temperature. First he shifts the given graph left by one hour, then he applies a vertical shift.

1. What vertical shift does Han need to apply to model the 45 degree Fahrenheit temperature in the refrigerator?
2. How does Han’s model compare to yours?

### Lesson 7 Summary

You can use the equation of a function to write an equation for its transformation. For example, let . Take the graph of , reflect it across the -axis, translate it up 10 units, and translate it left 3 units. What is an equation for this new function? The new function is related to by , since



Which means .

Sometimes you can recognize from the expression for a function that it is the transformation of a simpler function. For example, consider:

One way to obtain the expression for from is:

* adding 5 to the input to get
* multiplying the output by -1 to get
* adding 10 to the output to get

So the graph of is obtained from the graph of by translating left 5 units, reflecting across the -axis, and translating up 10 units. Consider the point on the graph of . After translating, reflecting, and translating again, it becomes the point on the graph of .





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