

Lesson 3.2.3: The Graph of a Function (Coding)

Targets:

1. I know techniques for graphing functions and relate the domain of a function to its graph.

Background Information (Computer Programming)

Computer programs are essentially instructions to computers on what to do when the user (you!) makes a request. For example, when you type a letter on your smart phone, the smart phone follows a specified set of instructions to draw that letter on the screen and record it in memory (as part of an email, for example). One of the simplest types of instructions a computer can perform is a *for-next loop*. Below is code for a program that prints the first 5 powers of 2:

```
Declare  $x$  integer
For all  $x$  from 1 to 5
    Print  $2^x$ 
Next  $x$ 
```

The output of this program code is

```
2
4
8
16
32
```

Here is a description of the instructions: First, x is quantified as an integer, which means the variable can only take on integer values and cannot take on values like $\frac{1}{3}$ or $\sqrt{2}$. The "For" statement begins the loop, starting with $x = 1$. The instructions between "For" and "Next" are performed for the value $x = 1$, which in this case is just to "Print 2." (Print means "print to the computer screen.") Then the computer performs the instructions again for the next x ($x = 2$), i.e., "Print 4," and so on until the computer performs the instructions for $x = 5$, i.e., "Print 32."

Practice 1

Perform the instructions in the following programming code as if you were a computer and your paper was the computer screen.

```
Declare  $x$  integer
For all  $x$  from 2 to 8
    Print  $2x + 3$ 
Next  $x$ 
```

Background Information (Part 2)

We can use almost the same code to build a set: First, we start with a set with zero elements in it (called the *empty set*), and then we increase the size of the set by appending one new element to it in each for-next step.

```
Declare  $x$  integer
Initialize  $G$  as {}
For all  $x$  from 2 to 8
    Append  $2x + 3$  to  $G$ 
    Print  $G$ 
Next  $x$ 
```

Note that G is printed to the screen after each new number is appended. Thus, the output shows how the set builds:

```
{7}
{7, 9}
{7, 9, 11}
{7, 9, 11, 13}
{7, 9, 11, 13, 15}
{7, 9, 11, 13, 15, 17}
{7, 9, 11, 13, 15, 17, 19}.
```

Practice 2

We can also build a set by appending ordered pairs. Perform the instructions in the following programming code as if you were a computer and your paper was the computer screen (the first few are done for you).

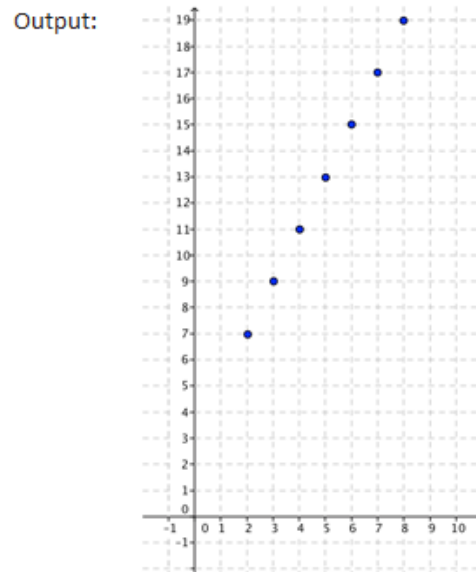
```
Declare  $x$  integer
Initialize  $G$  as {}
For all  $x$  from 2 to 8
    Append  $(x, 2x + 3)$  to  $G$ 
Next  $x$ 
Print  $G$ 
```

Output:
 $\{(2,7), (3,9), \underline{\hspace{15em}}\}$

Background Information (Part 3)

Instead of “Printing” the set G to the screen, we can use another command, “Plot,” to plot the points on a Cartesian plane.

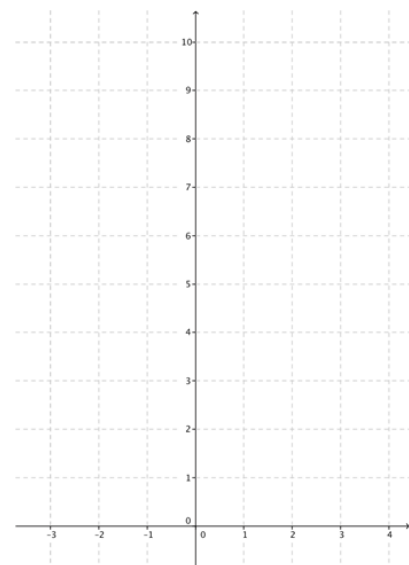
```
Declare  $x$  integer
Initialize  $G$  as {}
For all  $x$  from 2 to 8
    Append  $(x, 2x + 3)$  to  $G$ 
Next  $x$ 
Plot  $G$ 
```



Practice 3

Perform the instructions in the following programming code as if you were a computer and your paper was the computer screen.

```
Declare  $x$  integer
Initialize  $G$  as {}
For all  $x$  from  $-2$  to  $2$ 
    Append  $(x, -2x + 6)$  to  $G$ 
Next  $x$ 
Plot  $G$ 
```

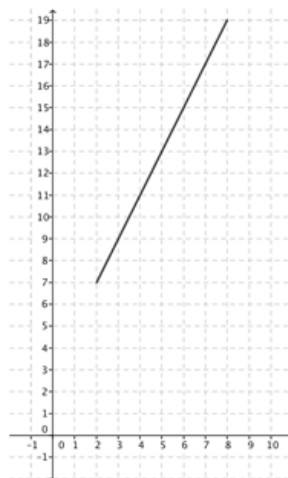


Background Information (Part 4)

We can now upgrade our notion of a for-next loop by doing a thought experiment: Imagine a for-next loop that steps through *all* real numbers in an interval (not just the integers). No computer can actually do this—computers can only do a finite number of calculations. But our human brains are far superior to that of any computer, and we can easily imagine what that might look like. Here is some sample code:

```
Declare  $x$  real
Let  $f(x) = 2x + 3$ 
Initialize  $G$  as {}
For all  $x$  such that  $2 \leq x \leq 8$ 
    Append  $(x, f(x))$  to  $G$ 
Next  $x$ 
Plot  $G$ 
```

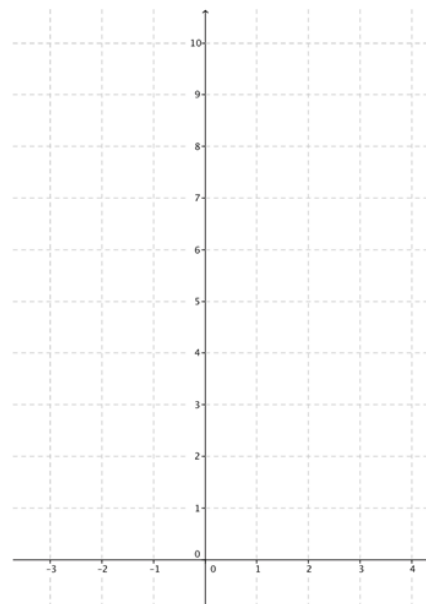
The output of this thought code is the graph of f for all real numbers x in the interval $2 \leq x \leq 8$:



Practice 4

Perform the instructions in the following programming code as if you were a computer and your paper was the computer screen.

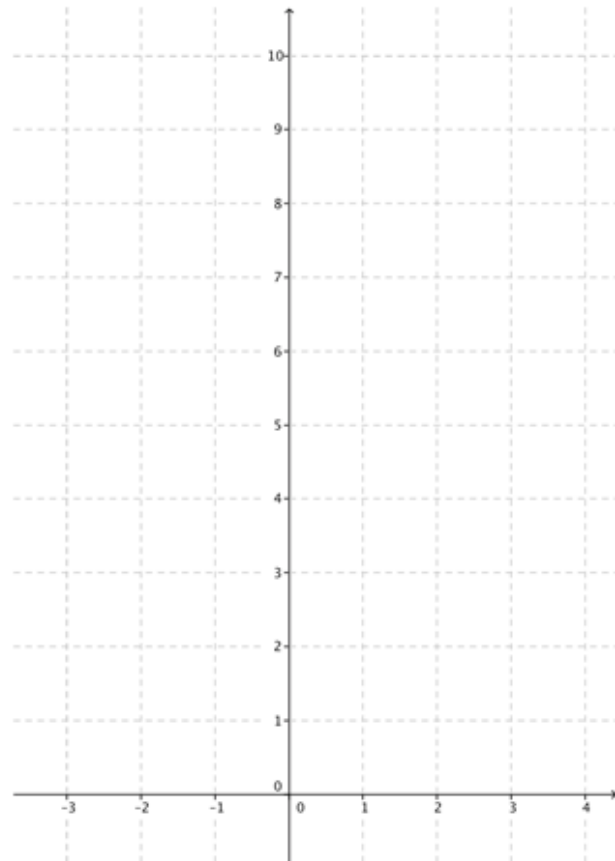
```
Declare  $x$  real
Let  $f(x) = -2x + 6$ 
Initialize  $G$  as {}
For all  $x$  such that  $-2 \leq x \leq 2$ 
    Append  $(x, f(x))$  to  $G$ 
Next  $x$ 
Plot  $G$ 
```



Exit Ticket

- a. Plot the function f on the Cartesian plane using the following for-next thought code.

```
Declare  $x$  real
Let  $f(x) = x^2 + 1$ 
Initialize  $G$  as {}
For all  $x$  such that  $-2 \leq x \leq 3$ 
    Append  $(x, f(x))$  to  $G$ 
Next  $x$ 
Plot  $G$ 
```



- b. For each step of the for-next loop, what is the input value?

- c. For each step of the for-next loop, what is the output value?

- d. What is the domain of the function f ?

- e. What is the range of the function f ?