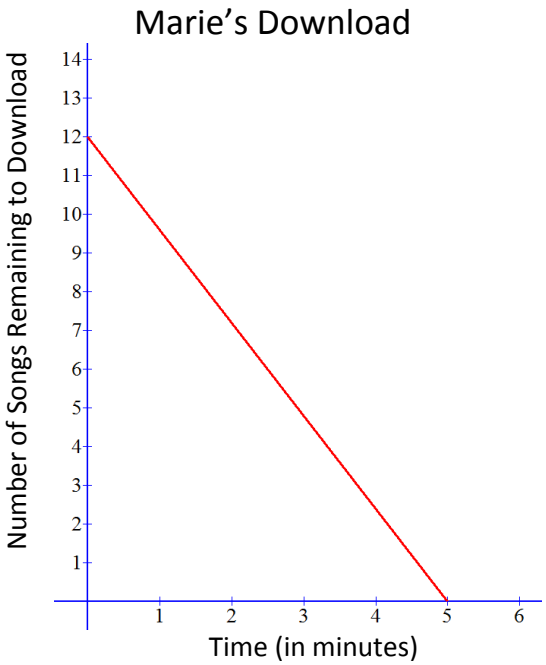
Task: Downloading Songs Task **8th Grade**

Marie and Scott each want to download the new album by their favorite artist. They are going to keep track of how fast they can download the album on separate computers.

Marie decides to represent downloading the album with a graph:



Scott decides to represent downloading the album with a table:

Time (in minutes)	Songs Downloaded
:45	2
2:15	6
3:00	8
3:45	10

A. **Explain what the points (0, 12) and (5, 0) represent on Marie's graph in the context of the problem.**
B. **Who was able to download the album faster? Explain how you determined your answer.**
C. **How long would it take each person to download 30 songs? Use equations to help you determine your answer.**
D. **Graph the relationship between the number of songs each can download and time on the same axes for Marie and Scott. Describe how the graphs are related in terms of slope, explaining what the slope represents.**

Common Core State Standards for Mathematical Content	Common Core State Standards for Mathematical Practice
8.EE.5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine*	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.

which of two moving objects has greater speed. 8.F.1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. 8.F.2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.*	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.

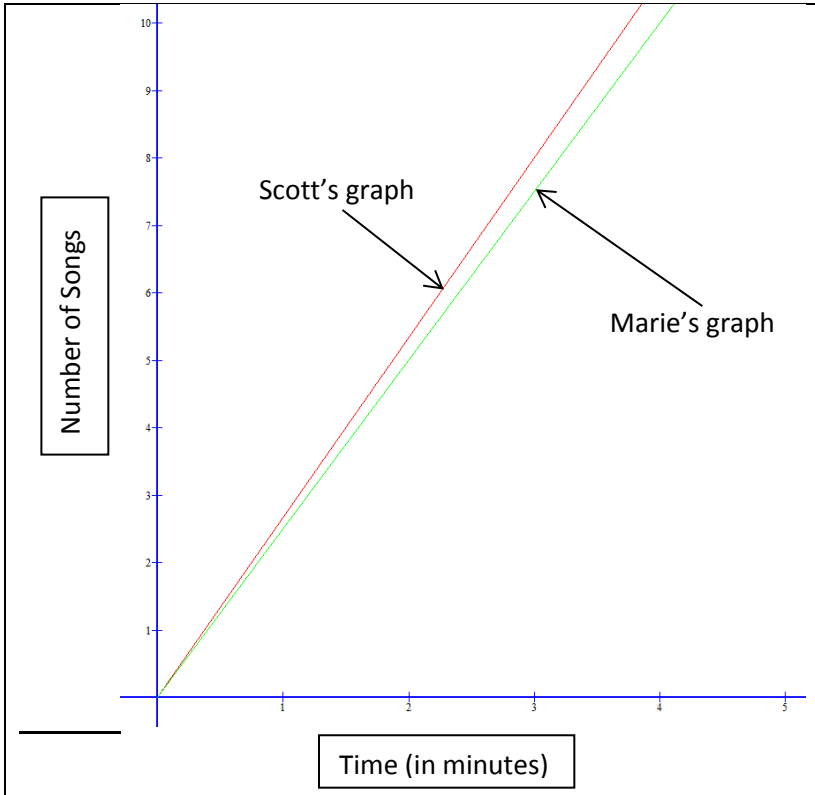
Essential Understandings

- Functions provide a tool for describing how variables change together. Using a function in this way is called *modeling*, and the function is called a *model*.
- Functions can be represented in multiple ways—in algebraic symbols, situations, graphs, verbal descriptions, tables, and so on—and these representations, and the links among them, are useful in analyzing patterns of change.
- Some representations of a function may be more useful than others, depending on how they are used.

Explore Phase

Possible Solution Paths	**Assessing and Advancing Questions**
PART A: (0, 12) represents that Marie has 12 songs remaining to download when the time is 0. *(Or, when Marie starts to download the album, she has 12 songs remaining).* (5, 0) represents that in 5 minutes, there will be no more songs to download. *(Or, it took 5 minutes for Marie to completely download the album).*	Assessing Questions Show me where (0,12) is on the graph. Show me (5,0) on the graph. Read the axes of the graph carefully. Advancing Questions Think about what is happening in the problem. How many songs is Marie downloading? How long will this take? How do you know?
PART B: Students may attempt to calculate a unit rate, in songs per minute: Marie can download 12/5 = 2.40 songs per minute Scott can download 8/3 $\approx$2.67 songs per minute So, Scott was able to download the album faster. Students may attempt to calculate a unit rate, in minutes per song: It takes Marie 5/12 $\approx$ .417 minutes per song It take Scott 3/8 = .375 minutes per song It takes Scott less time to download a song, so he was able to download the album faster.	Assessing Questions I see that you found the unit rate. Can you explain to me how you calculated each for Marie and Scott? Advancing Questions What does finding the unit rate tell you? How does this help you compare who was able to download faster?

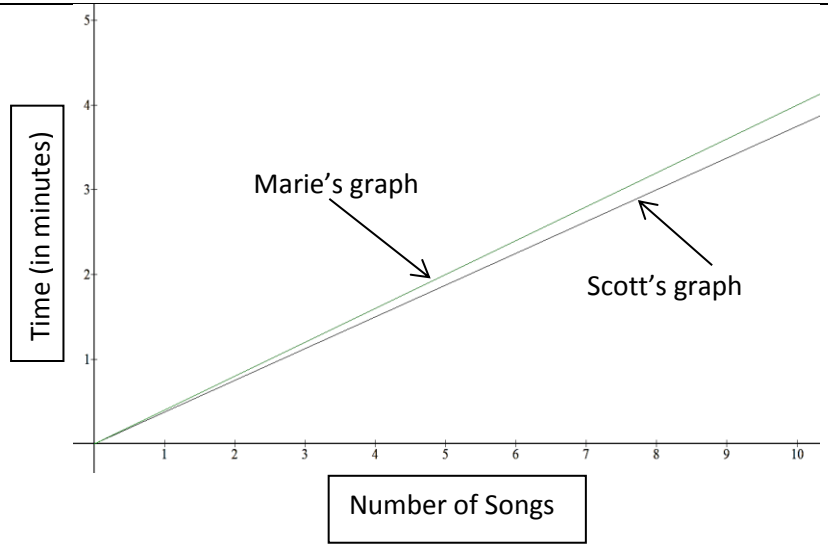
PART C: Marie: Using proportional reasoning: $\frac{12\,songs}{5\text{ min}} = \frac{30\,songs}{x}$ 12x = 5(30) x = 12.5 minutes, or 12:30, or 12 minutes and 30 seconds Scott: Using proportional reasoning: $\frac{8\,songs}{3\text{ min}} = \frac{30\,songs}{x}$ 8x = 3(30) x = 11.25 minutes, or 11:15, or 11 minutes and 15 seconds --OR— Marie: y = 12/5x (x is time, y is number of songs), *or y=2.4x* 30 = 12/5x, and x = 12.5 minutes, or 12:30, or 12 minutes and 30 seconds Scott: y = 8/3x (x is time, y is number of songs), *or y=2.67x* So, 30 = 8/3x, and x = 11.25 minutes, or 11:15, or 11 minutes and 15 seconds --OR— Marie: y = 5/12x (x is number of songs, y is time), *or y = .42x* y = 5/12(30) = 12.5 minutes, or 12:30, or 12 minutes and 30 seconds Scott: y = 3/8x (x is number of songs, y is time, *or y = .375x* y = 3/8(30) = 11.25 minutes, or 11:15, or 11 minutes and 15 seconds --OR— Scaling the unit rate: Marie: .417 x 30 = 12.51, round to 12.5 minutes, or 12:30, or 12 minutes and 30 seconds Scott: .375 x 30 = 11.25 minutes, or 11:15, or 11 minutes and 15 seconds	<u>Assessing Questions</u> Tell me how you set up your proportion. Is Marie's graph proportional? Why or why not? What relationship is proportional? <u>Advancing Questions</u> From part B, who did you expect to take less time to download? Is your answer consistent with part B? <u>Assessing Questions</u> Tell me about your equation. What does the 12/5 represent? What do the x and y represent? <u>Advancing Questions</u> Could you predict the time it takes for any number of songs? What if I asked you how many songs you could download in 20 minutes? How would you figure that out?
PART D: Downloading Songs	<u>Assessing Questions</u> Does each graph show a proportional relationship? How do you know? <u>Advancing Questions</u> Why is one graph different than the other? How can you describe the



Graphing the relationship between the number of songs (y) each can download and time (x) shows two linear functions that go through the origin – both are proportional relationships. Since Scott can down load songs faster, his graph is steeper, and the slope is greater when compared to Marie's graph.

Downloading Songs

relationship between the graphs, based on the context of the problem? What is the slope of each line and what does that tell you?



Graphing the relationship between time (y) and the number of songs (x) each can download shows two linear functions that go through the origin – both are proportional relationships. Because it takes more time per song for Marie to download, her graph is steeper, and the slope is greater when compared to Scott's graph.

Possible Student Misconceptions	
PART A: Students may be confused where points are located, mixing up the x and y coordinates. Students may not understand how to interpret the context with the graph.	Assessing Questions Which is the y coordinate and which is the x coordinate? What is happening in this problem – what does the graph show? Advancing Questions Look at the axes. What does each point on the graph represent? Can you tell me why the graph goes "down"?
PART B: Students may not know how to compare which person can download faster by abstracting appropriate values from the graph and/or table.	Assessing Questions How long did it take Marie to down load the album? Do you know how long it took Scott? How can we compare? Advancing Questions How can you figure out how long it took Marie to download one song? Scott?
PART C: Students may not understand that when comparing songs each can download and time, they are both proportional relationships.	Assessing Questions We know who can download one song faster. Does that tell you who can download 30 songs faster? How would you describe the relationship between time and the number of songs Marie and Scott can download?

	<u>Advancing Questions</u> How can you use the amount of time it takes Marie to download one song to figure out how long it will take her to download 30 songs? What equation can you set up between time and songs?
<u>PART D:</u> Students may not understand how unit rate is connected to the slope of the graph of a proportional relationship.	<u>Assessing Questions</u> Tell me how you graphed the relationship between the songs Marie and Scott could download and time. <u>Advancing Questions</u> Who could download songs faster? Can you describe the differences and similarities in the graphs? What is causing those?
Entry/Extensions	**Assessing and Advancing Questions**
If students can't get started….	<u>Assessing Questions</u> Tell me about what is going on in this problem. Explain what Marie's graph tells you. What does Scott's table tell you? <u>Advancing Questions</u> Think about the axes on Marie's graph. What do the y-values represent? The x-values? How can you use Marie's graph and Scott's table to determine who can download songs faster?
If students finish early….	<u>Assessing Questions</u> Explain how you decided who could download the songs faster. <u>Advancing Questions</u> Tell me how you described the relationship between the two graphs in terms of slope. What does the slope represent? What if Marie's graph had intersected the time axis at (4, 0)? How would that change your graph in part D?
Discuss/Analyze	
Whole Group Questions	
<u>PART A:</u> Who can tell me what this graph represents? Why is the graph going "down"? How many songs are in the album Marie and Scott are trying to download? How long did it take Marie to download the album? How can you determine this from looking at the graph?	
<u>PART B:</u> I see that some of you found unit rate to determine who could download the songs faster. But, I saw that some of you found unit rate one way and some of you found it a different way? Does it matter? How can finding unit rate both ways help you answer this question? Is there another way besides unit rate to determine who could download the songs faster?	
<u>PART C:</u>	

There were several different ways to determine how long it would take to download 30 songs. Someone who set up a proportion, tell us why you did and how you knew that would work. There were other equations used – why do those work? Who took the unit rate and scaled it up? What are the connections among all of these methods?

PART D:

Why is Scott's graph steeper than Marie's? What is the slope for each graph? How are the graphs related to the rate at which each person could download the songs? Why do we have two different graphs? Which representation is more useful in determining who can download the songs faster? Why?