Name: ____________________________________ Date: __________________

Modeling with Linear Functions
N-Gen Math® Algebra I

*When we use equations to **model** real-world phenomena, we often first look to **linear models** because they are the easiest to use and understand. We can now utilize our skills from the last few lessons to model real-world linear phenomena.*

Don't ever forget these two facts about linear models:

Critical Linear Modeling Facts

All linear models in the form $y = mx + b$ have two **parameters**, the **slope**, m, and the y**-intercept**, b:

1. The **slope**, m, always tells us how fast the **output** is changing relative to the **input**.
2. The y**-intercept**, b, always tells us "how much" we start with, or the **output's starting value** (at $x = 0$).

***Exercise* #1:** Jannine has \$450 in her savings account at the beginning of the year. She places an additional \$15 into her savings account at the end of each week. We want to model the amount of money she has in savings, s, as a function of the number of weeks she has been saving, w.

(a) Fill out the table below for some of the number of weeks. Show the calculations that result in your answer.

Number of weeks, w	Calculation	Amount in Savings, s
0		
1		
5		
10		

(b) Use information given or from the table to write an equation for the savings, s, as a linear function of the weeks she has been saving, w.

(c) How much money will Jannine have saved up after saving for 30 weeks?

(d) If Jannine saves for an entire year, then what is the domain of this function? Use proper notation or describe the set.

(e) Use the last two rows of the table in (a) to calculate the average rate of change of this function. Why does your answer make sense in the context of this problem?

Sometimes the information we have about the linear relationship does not include the starting value. Many times, we have two input-output pairs that allow us to find the equation of the linear function.

***Exercise* #2:** Lincoln is driving along a long road at a constant speed. He is keeping track of how far he is from Denver. He knows that after 2-hours of driving he is 272 miles from Denver. After 3.5 hours, he is 176 miles from Denver.

(a) Summarize the information given in the problem as two ordered pairs, where the number of hours, h, is the input and the distance from Denver, D, is the output.

(b) Calculate $\frac{\Delta D}{\Delta h}=\frac{D(3.5)-D(2)}{3.5-2}$. Include proper units in your answer.

(c) You should have found that the average rate of change in (b) was negative. Explain why this is in the context of this problem.

(d) Assuming the relationship is linear (which it would be at a constant speed), write an equation for the distance D as a linear function of the number of hours, h.

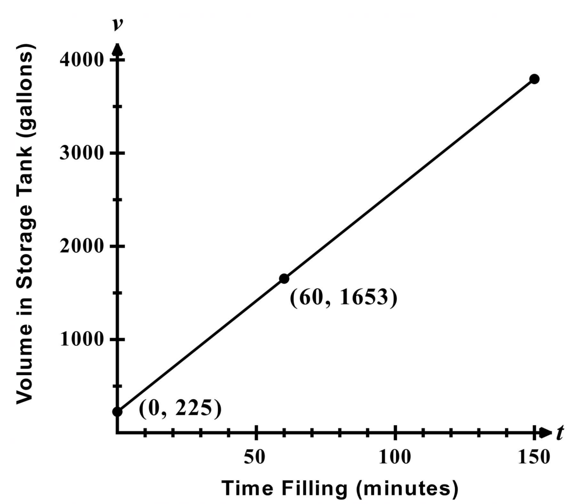
(e) How far did Lincoln start from Denver? Justify.

(f) After how many hours will Lincoln arrive in Denver? Show the work that leads to your answer.

***Exercise* #3:** A pump begins to fill a water storage tank when the volume drops to 225 gallons. The pump fills the tank at a steady rate for 150 minutes. After 60 minutes, there are 1,653 gallons in the storage tank, as shown on the graph.

(a) What is the slope of this linear function? Using proper units, explain what this slope represents in the context of this problem.

(b) What will the volume be in the storage tank after 150 minutes? Show how you found your answer.



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Modeling with Linear Functions
N-Gen Math® Algebra I Homework

Fluency

1. A truck bed is being filled with sand for a construction site. After two minutes, the bed contains 128 pounds of sand, and after four minutes, it contains 238 pounds of sand. What is the average rate that the sand is filling the truck between two and four minutes?

   (1) 55 pounds per minute (3) 64 pounds per minute

   (2) 60 pounds per minute (4) 72 pounds per minute

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2. A drone is released at a height of 5 feet above the ground and rises at a steady rate of 3 feet per second. Which equation below gives the height, h, of the drone above the ground as a function of the amount of time, t, in seconds it has been rising?

   (1) $h=5t+3$ (3) $h=3t+5$

   (2) $h=\frac{5}{3}t$ (4) $h=\frac{3}{5}t$

   ____

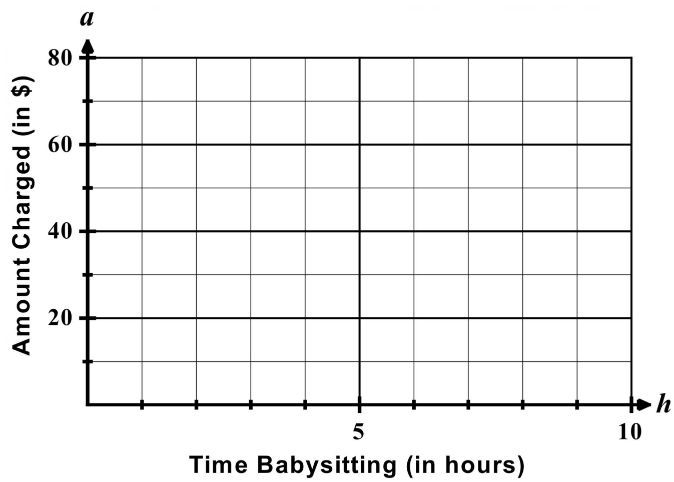
Applications

3. Maria charges \$15 for every 2 hours that she babysits. Answer the following questions based on this information.

   (a) Fill out the table below for how much Maria charges for certain times babysitting.

Hours, h	0	2	4	6	8	10
Amount, a, in \$						

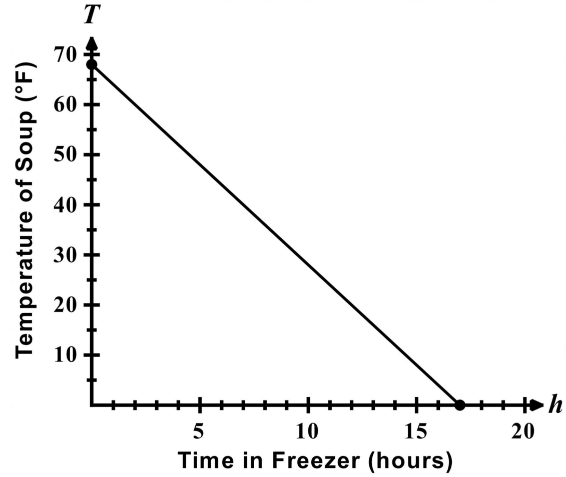
   (b) Create a graph of the linear function on the grid provided.



   (c) Write an equation for the amount, a, that Maria makes as a function of the number of hours, h, that she babysits.

   (d) Maria babysits for 13 hours one weekend. According to your model from (c), will she make more or less than \$100 for this work?

4. Liquid soup that is originally $68\ °F$ is placed in a freezer that is set at $0\ °F$. The soup begins to cool such that its temperature, T, is a linear function of the number of hours, h, it has been in the freezer. This linear relationship is shown below.



(a) How many hours does it take for the soup to reach the freezer's temperature of $0\ °F$?

(b) What is the slope of this linear relationship? Show your calculation and give appropriate units.

(c) Write a linear function for the temperature of the soup, T, as a function of the hours it has been in the freezer, h.

(d) Would the soup be liquid or solid after being in the freezer for 10 hours? Justify.

5. The population of deer in a park is growing over the years. The table below gives the population found in a survey by local wildlife officials.

Year	2010	2013	2016	2019
Deer Population	168	216	264	312

(a) Find the average rate that the deer population is changing over each time interval below:

From 2010 to 2013 From 2013 to 2016 From 2016 to 2019

(b) Why do the calculations from (a) support the idea that the population is a linear function of the number of years since 2010?

(c) If t stands for the number of years since 2010, write an equation for the deer population, p, as a function of t.

(d) What does your model predict the deer population to be in the year 2030?