2.2

What Goes Up Must Come Down

Analyzing Linear Functions

LEARNING GOALS

In this lesson, you will:

- Complete tables and graphs, and write equations to model linear situations.
- Analyze multiple representations of linear relationships.
- Identify units of measure associated with linear relationships.
- Determine solutions to linear functions using intersection points and properties of equality.
- Determine solutions using tables, graphs, and functions.
- Compare and contrast different problem-solving methods.
- Estimate solutions to linear functions.
- Use a graphing calculator to analyze functions and their graphs.

There are 3 ways to model linear equations.

PROBLEM 1 As We Make Our Final Descent

At 36,000 feet, the crew aboard the 747 airplane begins making preparations to land. The plane descends at a rate of 1500 feet per minute until it lands.

1. Compare this problem situation to the problem situation in Lesson 2.1, *The Plane!* How are the situations the same? How are they different?

Same: IQ = Time & DQ = Height.
Differences: ROC is negative & the starting point is not zero.

2. Complete the table to represent this problem situation.

	Independent Quantity	Dependent Quantity
Quantity	*Time*	*Height*
Units	*minutes*	*feet*
	0	36,000
	2	33,000
	4	30,000
	6	27,000
	12	18,000
	20	6000
Expression	t	$36000 - 1500t$

3. Write a function, g(t), to represent this problem situation.

$g(t) = 36000 - 1500t$

or

$g(t) = -1500t + 36000$

Slope-intercept Form

The plane is starting at 36,000 feet.

The rate of change is -1500 feet per minute.

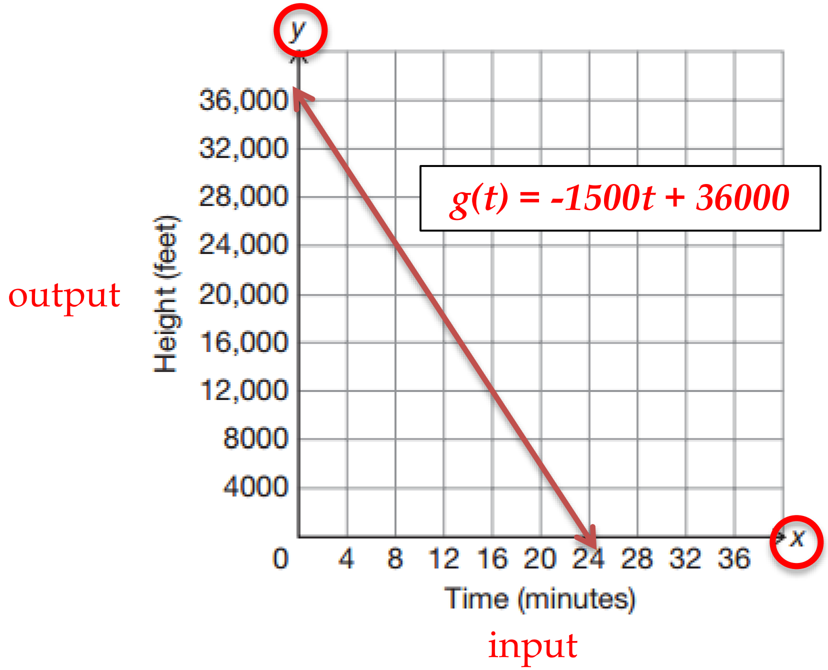
We are losing altitude!

4. Complete the table shown. First, determine the unit of measure for each expression. Then, describe the contextual meaning of each part of the function. Finally, choose a term from the word box to describe the mathematical meaning of each part of the function.

input value	output value	rate of change
y-intercept	*x*-intercept	

		Description	
Expression	**Units**	**Contextual Meaning**	**Mathematical Meaning**
t	minutes	Amt of time the plane descends	input value
-1500	$\frac{\text{feet}}{\text{minute}}$	# of feet the plane descends per min	rate of change
$-1500t$	feet	# of feet the plane descended	
36,000	feet	Plane's initial height	y-intercept
$-1500t + 36{,}000$	feet	Height of the plane	output value

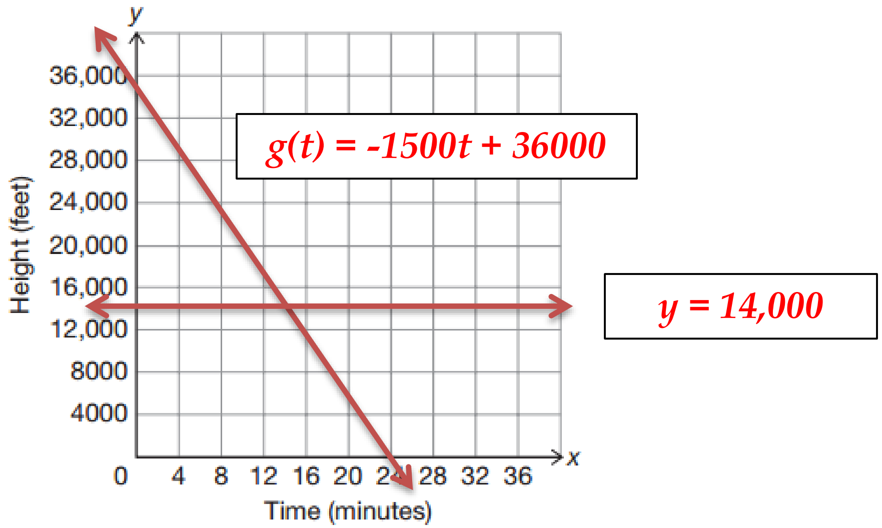
5. Graph $g(t)$ on the coordinate plane shown.



You have just represented the *As We Make Our Final Descent* scenario in different ways:

- numerically, by completing a table,
- algebraically, by writing a function, and
- graphically, by plotting points.

Let's consider how to use each of these representations to answer questions about the problem situation.



6. Determine how long will it take the plane to descend to 14,000 feet.

a. Use the table to determine how long it will take the plane to descend to 14,000 feet.
(Look at the table on page 88.) It takes 12 - 20 minutes.

b. Graph and label y = 14,000 on the coordinate plane. Then determine the intersection point. Explain what the intersection point means in terms of this problem situation.
Use the graph on page 89. Draw a horizontal line where y = 14,000.
The point-of-intersection (POI) is 12 – 16 minutes, or approximately 14 minutes.

c. Substitute 14,000 for g(t) and solve the equation for t. Interpret your solution in terms of this problem situation.

$$14000 = -1500t + 36,000$$

$$-22,000 = -1500t$$

$$14.\overline{6} = t$$

d. Compare and contrast your solutions using the table, graph, and the function. What do you notice? Explain your reasoning.
The table produces an estimate.
The graph gives you an approximation.
The function/equation results in an exact solution.

7. Determine how long it will take the plane to descend to 24,000 feet.

a. Use the table to determine how long it will take the plane to descend to 24,000 feet.
(Look at the table on page 88.) It takes 6 - 12 minutes.

b. Graph and label y = 24,000 on the coordinate plane. Then determine the intersection point. Explain what the intersection point means in terms of this situation.
Use the graph on page 89. Draw a horizontal line where y = 24,000.
The POI is (8, 24000). The plane descends to 24,000 feet in 8 minutes.

c. Substitute 24,000 for g(t) and solve the equation for t. Interpret your solution in terms of this situation.

$$24000 = -1500t + 36{,}000$$
$$-12{,}000 = -1500t$$
$$8 = t$$

c. Compare and contrast your solutions using the table, graph, and the function. What do you notice? Explain your reasoning.
Table = an estimated time
Graph = an exact time because the line intersects the corner of the coordinate grid when t = 8
Function = exact time

8. For how many heights can you calculate the exact time using the:

a. table?

6 rows in the table = you find the exact time for 6 different heights

b. graph?

4 places where the graph intersects a corner of the grid = you can find the exact time for 4 different heights

c. function?

You can always calculate an exact time for any given height.

9. Use the word bank to complete each sentence.

always	sometimes	never

If I am given a dependent value and need to calculate an independent value of a linear function,

a. I can ___always___ use a table to determine an *approximate* value.

b. I can ___sometimes___ use a table to calculate an *exact* value.

c. I can ___always___ use a graph to determine an *approximate* value.

d. I can ___sometimes___ use a graph to calculate an *exact* value.

e. I can ___always___ use a function to determine an *approximate* value.

f. I can ___always___ use a function to calculate an *exact* value.