Name _____ Date _____ Class _____

LESSON

Reteach

9-1 *Multiple Representations of Functions*

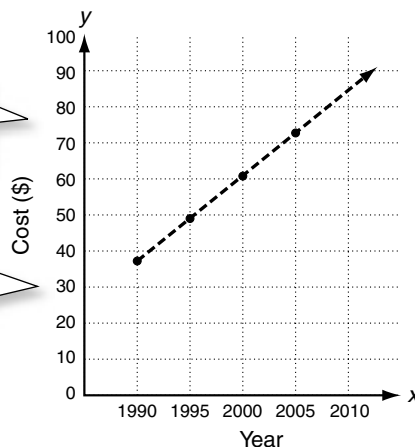You can use a representation of a function to create a different representation of the same function.

The table shows the cost of renting mountain bikes for 5 days at Outdoor Biker from 1990 through 2005.
Use the table to create a graph and an equation.

Year	Cost ($)
1990	37
1995	49
2000	61
2005	73

Plot the ordered pairs on the graph

The graph suggests the data are **linear.**

Write a linear equation.

Step 1 Define the variables. Let $x =$ year and $y =$ the rental cost.

Step 2 Find the slope. Choose two points: $(1990, 37)$ and $(1995, 49)$.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{49 - 37}{1995 - 1990} = \frac{12}{5} = 2.4$$

(x_1, y_1) (x_2, y_2)

Step 3 Write the equation of the line using the point-slope form.

$$y - y_1 = m(x - x_1)$$

$$y - 37 = 2.4(x - 1990)$$

Use $m = 2.4$ and $(1990, 37)$ for (x_1, y_1).
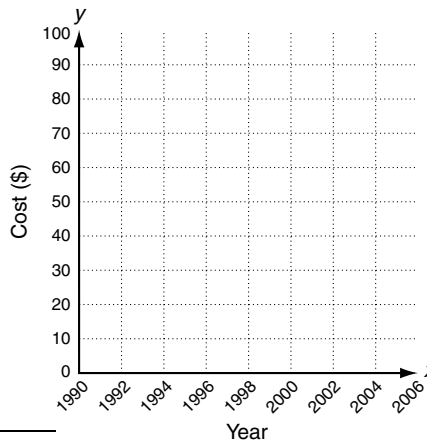
$$y = 2.4x - 4739$$

Use the equation to predict the cost of renting a mountain bike in 2007.

$$y = 2.4x - 4739 = 2.4(2007) - 4739 = \$77.80$$

The table shows the cost of renting ocean kayaks for a week at Ocean Adventures. Use the table to solve.

1. Use the data to create a graph.

Year	Cost ($)
1992	28
1996	42
2000	56
2004	70

2. Write a linear equation. _____

3. Predict the cost of renting a kayak in 2006. _____

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6

Holt Algebra 2

Name _____ Date _____ Class _____

Reteach
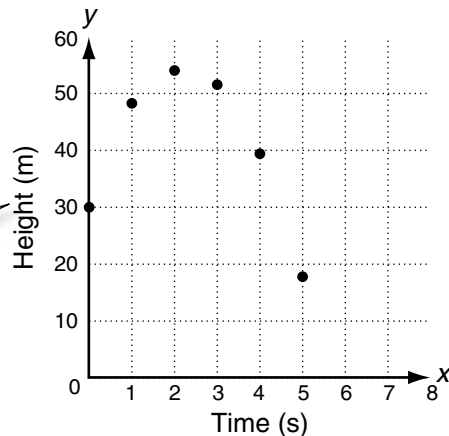## *Multiple Representations of Functions (continued)*

Different representations can be used to solve problems about nonlinear functions.

The table shows the height of a rocket after it is fired. When does the rocket reach its maximum height?

Time (s)	Height (m)
0	30.0
1	47.1
2	54.4
3	51.9
4	39.6
5	17.5

Step 1 Make a scatter plot.

The graph suggests the data are not linear.

Step 2 Check finite differences.
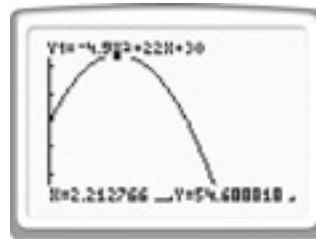
First differences: 17.1   7.3   −2.5   −12.3   −22.1

Second differences: −9.8   −9.8   −9.8   −9.8

Step 3 Second differences are constant. Use a graphing calculator to find the quadratic regression (QuadReg) equation:
$y = -4.9x^2 + 22x + 30$.

$y = ax^2 + bx + c$
$a = -4.9$
$b = 22$
$c = 30$
$r^2 = 1$

Step 4 Use TRACE to find the maximum height.

The rocket has a maximum height of about 54.7 m at about 2.2s.

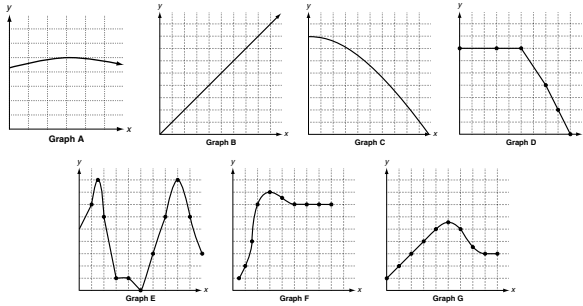**The table shows the height of a rocket after it is fired. Solve.**

Time (s)	Height (m)
0	45
1	58.1
2	61.4
3	54.9
4	38.6
5	12.5

4. Are the first differences constant? _____

5. Are the second differences constant? _____

6. Find an equation to model the data.

_____

7. When does the rocket reach its maximum height?

_____

Holt Algebra 2

Match each situation to its corresponding graph.

Graph A   Graph B   Graph C   Graph D

Graph E   Graph F   Graph G

1. A bowling ball rolls down the alley and drops into a trough behind the pins. Which graph shows a horizontal line that suddenly drops? _____ D

2. As a flower vase is filled with water, the level of the water rises. _____ B

3. A football is kicked and then caught by a person who runs down the football field with it. _____ G

4. The sales of wide-screen televisions increase rapidly, peak, and then level off. _____ F

5. Ice cream sales were steady all day at the music festival. _____ A

6. A restaurant opens late in the morning, experiences a lunchtime rush, and then empties right before the dinner rush. _____ E

7. The noise level of traffic decreases after the evening rush hour. _____ C

Solve.

8. A train begins a trip of 240 miles. The train averages 40 miles per hour including stops. Create a table, a graph, and an equation to represent the distance the train travels in relation to time.

Time (h)	0	1	2	3
Distance (mi)	0	40	80	120

$$d = 40t$$
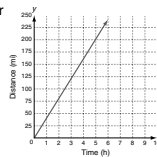
3 **Holt Algebra 2**

Match each situation to its corresponding graph. Sketch a possible graph of the situation if it does not match any of the given graphs.


Graph A   Graph B   Graph C   Graph D
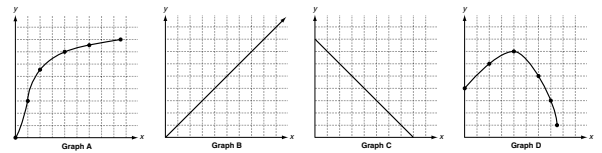
1. A train is approaching its destination. _____ C

2. The temperature on an autumn day increases until late afternoon and then drops dramatically by late evening. _____ D

3. A helium balloon is released by a running child on a calm day. _____ B

4. A golf ball hit by a golfer flies over the trees and disappears into the woods. _____ A

Solve.

5. A bicyclist leaves a rest stop at 1:00 and heads directly for home at a constant rate. The table shows how far, *d*, he is from home in miles as a function of time, *t*. Create a graph and an equation to predict the time he will arrive home.

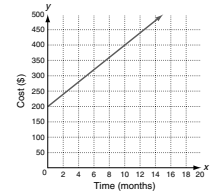| t	1:00	1:10	1:20	1:30	1:40
d	18.5	16.0	13.5	11.0	8.5

$$d = -0.25t + 17.5$$
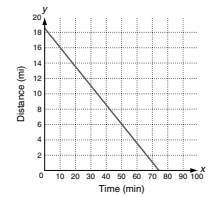
6. New members at a fitness club pay $200 to start and then $20 per month for life. Create a table, a graph, and an equation that represent the total cost of enrollment, *c*, as a function of months, *m*, of participation.

m	1	2	3
c	220	240	260

$$c = 20m + 200$$

4 **Holt Algebra 2**

Match each situation to its corresponding graph. Sketch a possible graph of the situation if it does not match any of the given graphs.

Graph A   Graph B   Graph C   Graph D
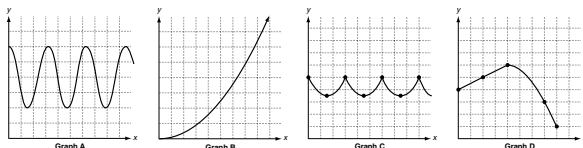
1. A pendulum swings back and forth. _____ C

2. A new subdivision is built near an elementary school and families with children begin moving in. _____ B

3. Joan throws a paper airplane into the air. _____ D

4. Sandy is riding the roller coaster at the amusement park. _____ A

Solve.

5. The table shows the balance, *b*, in dollars in a savings account at the end of each month. Create a graph and an equation to represent the balance after *m* months.

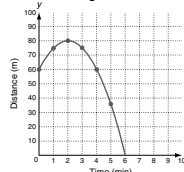| m	1	2	3	4	5	6
b	38	46	54	62	70	78

$$b = 8m + 30$$
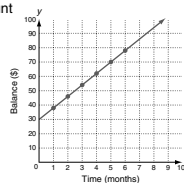
6. A fireworks projectile is launched at 20 meters per second from a 60-meter bridge. The table shows the distance, *d*, in meters the projectile is above the river after *t* seconds. Create a graph and an equation to determine how long after the launch the projectile reaches the ground.

t	0	1	2	3	4	5
d	60	75	80	75	60	35

$$d = -5t^2 + 20t + 60$$
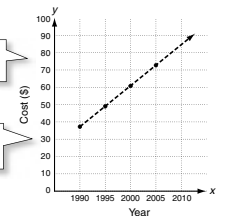
5 **Holt Algebra 2**

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$$y - y_1 = m(x - x_1)$$
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$$y = 2.4x - 4739$$

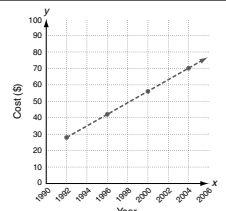Use the equation to predict the cost of renting a mountain bike in 2007.
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The table shows the cost of renting ocean kayaks for a week at Ocean Adventures. Use the table to solve.

1. Use the data to create a graph.

Year	Cost ($)
1992	28
1996	42
2000	56
2004	70

2. Write a linear equation. _____ $y = 3.5x - 6944$

3. Predict the cost of renting a kayak in 2006. _____ $77

6 **Holt Algebra 2**

Reteach
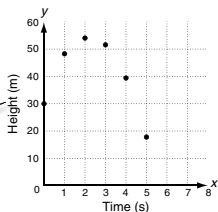### Multiple Representations of Functions (continued)

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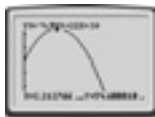The graph suggests the data are not linear.

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Time (s)	Height (m)
0	45
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4	38.6
5	12.5

4. Are the first differences constant? **No**

5. Are the second differences constant? **Yes**

6. Find an equation to model the data.

$y = -4.9x^2 + 18x + 45$

7. When does the rocket reach its maximum height?

**About 61.5 m at about 1.9 s**

7

Challenge
Find a Function to Fit

Some real-world problems can be modeled using functions. Consider a home owner in Maine faced with deciding which type of heating system to install in a new home. A solar system will cost $20,000 to install, but the annual heating costs will be $1000. A geothermal heat pump will cost $15,000 to install with annual heating costs of $1500. A conventional oil-fired furnace will cost $6000 to install with annual heating costs of $2400.

1. Write a function to represent the total cost of each system over t years.

$f(t) = 20,000 + 1000t, \; g(t) = 15,000 + 1500t, \; h(t) = 6000 + 2400t$

2. Graph each function over 20 years.
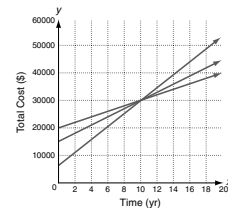
3. If the home owner plans to move within 7 years, which heating system is most economical?

Oil-fired furnace

4. Which system is better for a home owner who is planning to live in the house for 30 or more years? How do you know?

Solar system; after 10 years, this system is least expensive.

Consider the graph below. Three functions are shown: a linear function, $f(x)$, a quadratic function, $g(x)$, and a square root function, $h(x)$.

5. Identify three points on each graph.

a. $f(x)$ **$f(x)$: (0, 15), (10, 10), (20, 5)$**

b. $g(x)$ **$g(x)$: (5, 20), (15, 15), (25, 0)$**

c. $h(x)$ **$h(x)$: (−5, 0), (4, 12), (20, 20)$**
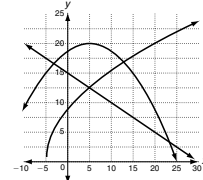
6. Find an equation that models $f(t)$.

$f(x) = -0.5x + 15$

7. Find an equation that models $g(t)$. Remember, every quadratic function is of the form $y = ax^2 + bx + c$. Set up a system of equations and solve for a, b, and c.

$g(x) = -0.05(x - 5)^2 + 20 = -0.05x^2 + 0.5x + 18.75$

8. Find an equation that models $h(t)$. A square root function can be modeled with $y = a\sqrt{x - h} + k$.

$h(x) = 4\sqrt{x + 5}$

8

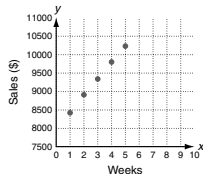## Problem Solving
Multiple Representations of Functions

Yvonne opened a new video game store. The table shows a record of her sales for the first five weeks. To break even, she needs to sell at least $12,500 worth of merchandise each week. She assumes the sales trend will continue and wants to know what to expect over the next weeks.

Weekly Store Sales	
Week	**Sales ($)**
1	8470
2	8920
3	9360
4	9790
5	10,210

1. Graph the data using weeks as the independent variable and sales as the dependent variable.

2. Yvonne thinks she can model her sales data using a quadratic function. Is she correct? How do you know?

Yes, because second differences are constant. For a quadratic function, second differences are constant.

3. Use a graphing calculator to perform the appropriate regression on the data. Write the equation that models the data.

$y = -5x^2 + 465x + 8010$

4. What sales can Yvonne expect in week 6? **$10,620**

5. When will her sales exceed $11,000 per week? **Week 7**

6. When will she break even? **Week 11**

7. When will sales be twice the sales of week 1? **Week 28**

Choose the letter for the best answer.

8. Which equation represents a steady increase of $420 per week in sales from week 5 on?

A $y = -420x + 10,210$

B $y = 420x + 10,210$

C $y = -5x^2 + 420x + 10,210$

D $y = -420x^2 + 10,210x$

9. During which week will Yvonne break even if the sales pattern changes and sales in week 6 and week 7 are $10,640 and $11,080, respectively?

F Week 9

G Week 10

H Week 11

J Week 12

9

Reading Strategies
Identify Relationships

You can represent functions in several ways. You can use an equation, a table, or a graph. Each representation gives the same information.

Equation	Table		Graph
$y = 2x$ When $x = 1$, $y = 2$.	**x**	**y**	
	1	2	
	4	8	
	7	14	
	10	20	
	When $x = 1$, $y = 2$.		When $x = 1$, $y = 2$.

x	−4	−1	0	2
y	3	−6	−5	3

Table R

x	6	9	12	15
y	2	3	4	5

Table S

Graph L — $y = \dfrac{x}{3}$ (Equation A)

Graph M — $y = x^2 + 2x - 5$ (Equation B)

Graph N — $y = x - 4$ (Equation C)

x	−5	−1	2	10
y	−9	−5	−2	6

Table T

Identify the relationships between the graphs, tables, and equations shown above. Explain your reasoning.

1. Which table and graph have a relationship with Equation A?

Table S and Graph N; possible answer: All the x-values are divided by 3 to get the y-values. The graph is linear and passes through the origin.

2. Which graph and equation have a relationship with Table R?

Graph L and Equation B; possible answer: The y-values alternate positive, negative, positive, so it is not linear.

3. Which equation and table have a relationship with Graph M?

Equation C and Table T; possible answer: The graph is linear and passes through the point (0, −4). In Table T the y-values are always four less than the x-values.

10