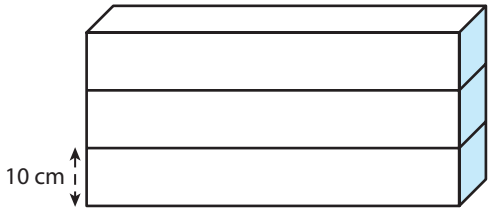
Direct and Inverse Variation
Stacking Boxes

ACTIVITY
2.5

SUGGESTED LEARNING STRATEGIES: Create Representations, Quickwrite, Think/Pair/Share, Look for a Pattern

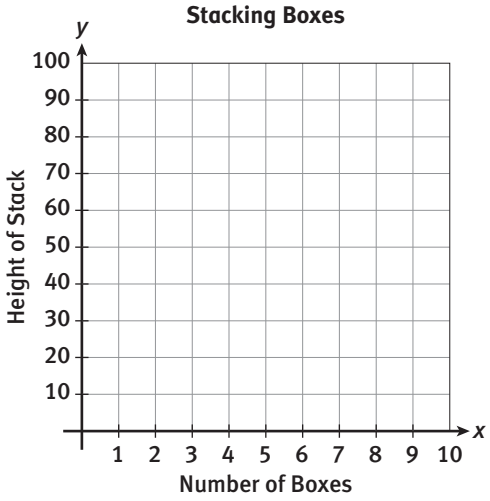
My Notes

You work for a packaging and shipping company. As part of your job there, you are part of a package design team deciding how to stack boxes for packaging and shipping. Each box is 10 cm high.



1. Complete the table and make a graph of the data points (number of boxes, height of the stack).

Number of Boxes	Height of the Stack (cm)
0	0
1	10
2	
3	
4	
5	
6	
7	



2. Write a function to represent the data in the table and graph above.

3. What do the $f(x)$, or y, and the x represent in your equation from Item 2?

4. What patterns do you notice in the table and graph representing your function?

WRITING MATH

Remember either y or $f(x)$ can be used to represent the output of a function.

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My Notes

SUGGESTED LEARNING STRATEGIES: Activate Prior Knowledge, Create Representations, Interactive Word Wall, Quickwrite, Discussion Group

ACADEMIC VOCABULARY

direct variation

5. The number of boxes is directly proportional to the height of the stack. Use a proportion to determine the height of a stack of 12 boxes.

6. When two values are directly proportional, there is a direct variation. In terms of stacking boxes, the _____ *varies directly* as the _____.

Therefore, this function is called a **direct variation**.

7. Using variables x and y to represent the two values, you can say that y varies directly as x. Use your answer to Item 6 to explain this statement.

8. Direct variation is defined as $y = kx$, where $k \neq 0$ and the coefficient k is the **constant of variation**.

a. Consider your answer to Item 2. What is the constant of variation in your function and why do you think it is called that?

b. Why can't k equal zero?

c. Write an equation for finding the constant of variation by solving the equation $y = kx$ for k.

9. a. What does the point (0, 0) mean in your table and graph?

b. True or False? Explain your answer.
"The graphs of all direct variations are lines that pass through the point (0, 0)."

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SUGGESTED LEARNING STRATEGIES: Create Representations, Identify a Subtask, Group Presentation

My Notes

Now use what you have learned about direct variation to answer questions about stacking and shipping your boxes.

10. The height y of a different stack of boxes varies directly as the number of boxes x. For this type of box, 25 boxes are 500 cm high.

a. Find the value of k.

b. Write a direct variation equation that relates y, the height of the stack, to x, the number of boxes in the stack.

c. How high is a stack of 20 boxes? Use your equation to answer this question.

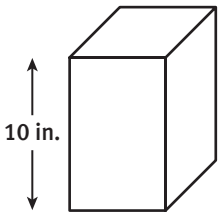
11. At the packaging and shipping company, you get paid each week. One week you earned \$48 for 8 hours of work. Another week you earned \$30 for 5 hours of work.

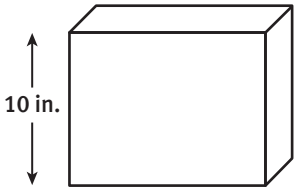
a. Write a direct variation equation that relates your wages to the number of hours you worked each week.

b. How much do you earn per hour?

c. How much would you earn if you worked 3.5 hours in one week?

When packaging a different product, the team determines that all boxes will have a volume of 400 cubic inches and a height of 10 inches. The lengths and the widths will vary.





MATH TIP

The volume of a rectangular prism is found by multiplying length, width, and height: $V = lwh$.

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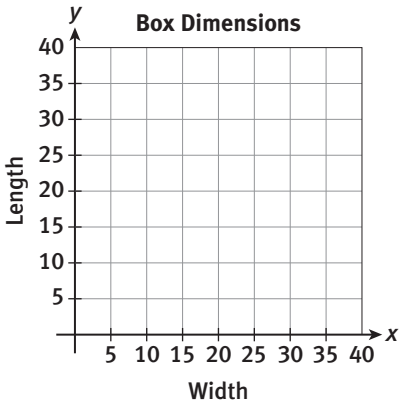
My Notes

SUGGESTED LEARNING STRATEGIES: Create Representations, Quickwrite, Think/Pair/Share, Look for a Pattern

12. To explore the relationship between length and width in the situation on the previous page, complete the table and make a graph of the points.

Width	Length
1	40
2	20



13. How did you figure out the lengths and widths in Item 12?

14. Write a function to represent the data in the table and graph above.

15. What do the $f(x)$, or y, and the x represent in your equation from Item 14?

16. What patterns do you notice in the table and graph representing your function?

ACADEMIC VOCABULARY

inverse variation

In terms of box dimensions, the length of the box varies indirectly as the width of the box. Therefore, this function is called an indirect variation, also known as **inverse variation**.

17. Compare and contrast direct and inverse variation.

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SUGGESTED LEARNING STRATEGIES: Create Representations, Quickwrite, Think/Pair/Share, Discussion Group

My Notes

18. Recall that direct variation is defined as $y = kx$, where $k \neq 0$ and the coefficient k is the constant of variation.

a. How would you define inverse variation in terms of y, k, and x?

b. Are there any limitations on these variables as there are on the k in direct variation? Explain.

c. Write an equation for finding the constant of variation by solving for k in your answer to part (a).

19. Use your equation in 14 to determine the following measurements for your company.

a. Find the length of a box whose width is 80 inches.

b. Find the length of a box whose width is 0.5 inches.

20. The time, y, to finish loading the boxes varies inversely as the number of people, x, working. If 10 people work, the job is completed in 20 h.

a. Find the value of k.

b. Write an inverse variation equation that relates the time to finish loading the boxes to the number of people working.

c. How long does it take 8 people to finish loading the boxes? Use your equation to answer this question.

MATH TIP

In Item 18c you are solving a literal equation for the variable, k. Try solving these literal equations for the given variable.

1. $A = l \cdot w$; for w
2. $ax + by = c$; for y
3. $d = r \cdot t$; for r

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My Notes

SUGGESTED LEARNING STRATEGIES: Marking the Text, Create Representations, Identify a Subtask, Group Presentation

21. The cost for the company to ship the boxes varies inversely with the number of boxes being shipped. If 25 boxes are shipped at once, it will cost \$10 per box. If 50 boxes are shipped at once, the cost will be \$5 per box.

a. Write an inverse variation equation that relates the cost per box to the number of boxes being shipped.

b. How much would it cost to ship only 10 boxes?

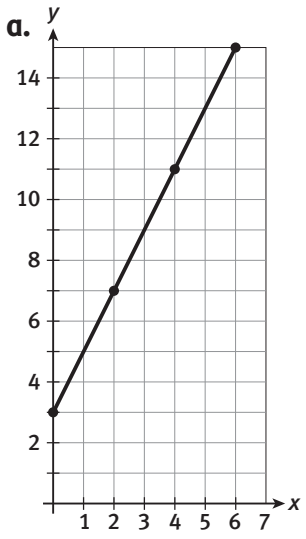
CHECK YOUR UNDERSTANDING

Write your answers on notebook paper. Show your work.

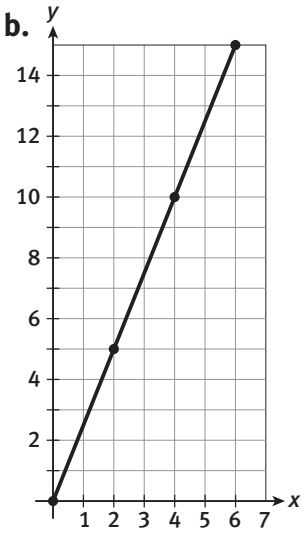
1. In the equation $y = 15x$, what is the constant of variation?

2. Identify the examples of direct variation from tables, graphs and equations below. Explain how you made your decision.

a.



b.



c.

x	y
2	12
4	24
6	36

d.

x	y
2	8
4	12
6	16

e. $y = 20x$

f. $y = 3x + 2$

3. y varies directly as x. If $y = 300$ when $x = 20$, find y when $x = 7$.

4. The height of a stack of boxes varies directly wih the number of boxes. A stack of 12 boxes is 15 feet high. How tall is a stack of 16 boxes?

5. In the equation $y = \frac{80}{x}$ what is the constant of variation?

6. Which equations are examples of inverse variation? Explain your answers.

a. $y = 2x$ **b.** $y = \frac{x}{2}$

c. $y = \frac{2}{x}$ **d.** $xy = 2$

7. y varies inversely as x. If $y = 8$ when $x = 20$, find y when $x = 10$.

8. MATHEMATICAL REFLECTION Create a graphic organizer that helps you to compare and contrast direct and inverse variation equations.

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