FUNCTIONS 1
STUDENT PACKET

INTRODUCTION TO LINEAR FUNCTIONS

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FUN1.1 Saving for a Purchase 2
- Use numbers, graphs, equations, and words to solve problems.
- Recognize that some real-world situations can be modeled using linear functions.
- Connect the *y*-intercept to a context.

FUN1.2 Geometric Patterns 6
- Describe sequences of numbers generated by geometric patterns using tables, graphs, and verbal descriptions.
- Plot ordered pairs that satisfy a given condition.
- Develop rules that describe sequences.
- Connect the *y*-intercept to a context.

FUN1.3 Best Buy Problems 10
- Use tables, graphs, equations, and verbal descriptions to determine the best buy, based on price.
- Write equations that represent relationships between cost and quantity.
- Define and identify functions that model proportional relationships.
- Identify unit rates from equations and graphs.

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Parent (or Guardian) signature ___________________________________

MY WORD BANK

Explain the mathematical meaning of each word or phrase, using pictures and examples when possible. (See section 1.5.) Key mathematical vocabulary is underlined throughout the packet.

function	input-output rule
linear function	ordered pair
proportional relationship	*y*-intercept

THE SUPER BOWL

Year	Super Bowl Champion
1970	Kansas City Chiefs
1971	Baltimore Colts
1972	Dallas Cowboys
1973	Miami Dolphins
1974	Miami Dolphins
1975	Pittsburgh Steelers
1976	Pittsburgh Steelers
1977	Oakland Raiders
1978	Dallas Cowboys
1979	Pittsburgh Steelers

Refer to the table at the right about Super Bowl champions in the 1970's.

1. Which teams won exactly once in the 70's?

2. Which team(s) won exactly twice?

3. Which team(s) won exactly three times?

4. Circle CAN or CAN NOT to make these two statements true. Then complete the example.

   a. If we look at any single year, we CAN CAN NOT always tell which team won.

      Example: In ___________ (year) I know that ___________ (team) won.

   b. If we look at any team, we CAN CAN NOT always tell which one year it was they won.

      Example (create your own):

5. Look up function in section 1.5 and discuss the definition with your teacher and classmates.

6. If "year" is the input and "champion" is the output, does this table represent a function? Explain.

7. If "champion" is the input and "year" is the output, does this table represent a function? Explain.

SAVING FOR A PURCHASE

We will represent input-output rules using equations, tables and graphs. We will use these representations to find out how much time is needed to save for a purchase.

GETTING STARTED

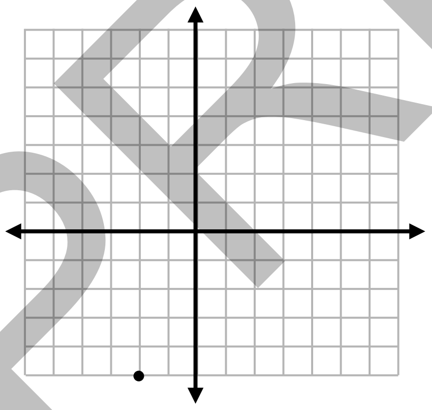
Use the rules given below to determine the output numbers. Then graph the (*x*, *y*) ordered pairs. Write an equation for the rule using x for input and y for output.

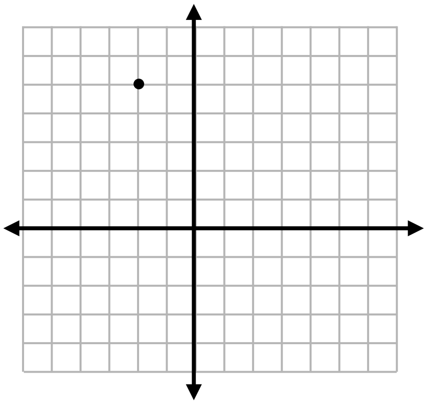
1. **Rule**: Multiply 3 by each input number and then add 1 to get each output number.

Input Number (*x*)	**Output Number (*y*)**
-2	(3)(-2) + 1 = -5
-1	
0	
1	
2	
Equation:	

2. **Rule**: Multiply each input number by itself and then add 1 to get each output number.

Input Number (*x*)	**Output Number (*y*)**
-2	(-2)(-2) + 1 = 5
-1	
0	
1	
2	
Equation:	





3. These rules represent functions. Explain which you think is linear and which you think is not linear. Hint: Write the definition of linear function in My Work Bank. See section 1.5.

SAVING FOR A BICYCLE

Colin and Indigo want to buy the same bike. Who saves enough to buy it first? Follow your teacher’s directions to complete this page.

PRACTICE 1

How many months will it take Luke and Rex to each save up for the phone?

- Luke wants to save for a phone that costs $200. He has $100 in the bank as a starting amount, and he is going to save $10 each month.
- Rex wants to save for the same phone. He has $40 in the bank as a starting amount, and he is going to save $25 each month.

1. The cost of the phone is _____. Luke still needs to save _____ and Rex still needs to save _____.

2. Let ***m*** represent the amount of money that each boy will deposit in their the bank account each ***month*** and let ***b*** represent the amount that is in the ***bank*** to start. Use the tables as needed. Write an equation for the total amount saved each month.

Luke: m = _____ b = _____

Rex: m = _____ b = _____

LUKE

x (# of months)	y (total amount saved in $)
0	10(0) + 100 = 100
1	10(_____) + 100 = _____

y = __________

REX

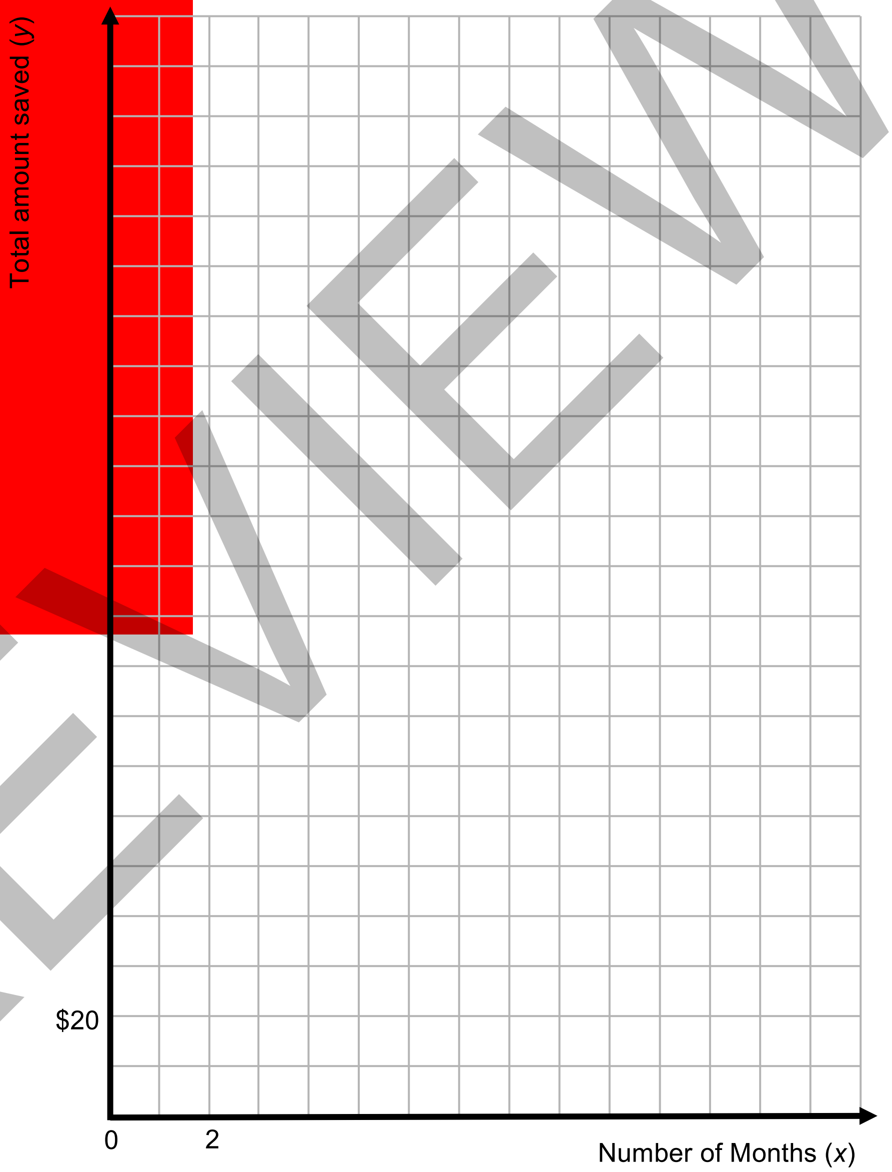
x (# of months)	y (total amount saved in $))
	25(_____) + 40 = _____

y = __________

PRACTICE 1

(Continued)

3. Use the data from the tables on the previous page to make graphs representing the total amount of money that Luke and Rex have saved each month. Use one color for Luke's graph and another color for Rex's graph.



4. Who starts out with more money in the bank?

   What ordered pair represents this on the graph?

   What is this point called?

5. Which boy's line is steeper?

   Does this show that he is saving at a faster or slower monthly rate? Use information from the previous page if it is helpful.

6. At what month will both boys have saved the same amount of money?

   Describe what this looks like on the graph.

7. Who saves enough for the phone first? Explain how you know.

GEOMETRIC PATTERNS

We will extend geometric “toothpick” patterns. We will use numbers, pictures, symbols, and words to describe these patterns.

GETTING STARTED

Fill in missing numbers and blanks based on the suggested patterns.

1.

x	1	2	3	4	5	6
y	5	7	9	11	13	

a. As *x* increases by 1, *y* increases by _____.

b. As *x* increases by 2, *y* increases by _____.

2.

x	1	2	3	4	5	6
y	4	8	12	16	20	

a. As *x* increases by 1, *y* increases by _____.

b. Multiply any *x*-value by _____ to get its corresponding *y*-value.

3.

x	1	2	3	4	5	6
y	6	10	14	18	22	

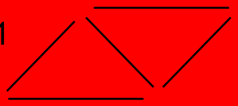
a. As *x* increases by 1, *y* increases by _____.

b. Multiply any *x*-value by _____ and then add _____ to get its corresponding *y*-value.

TRIANGLES

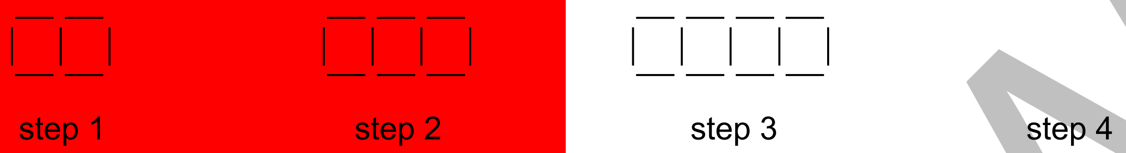
Follow your teacher’s directions to complete this page.

Step 1



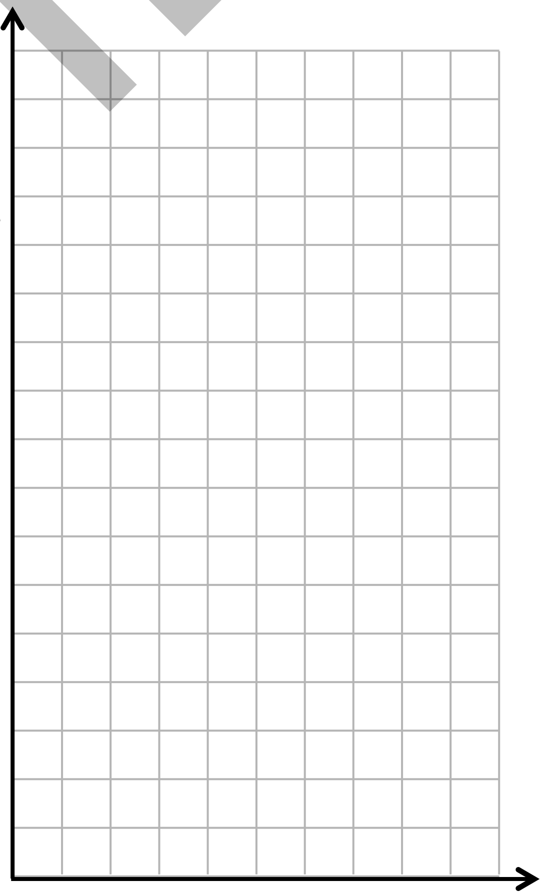
PRACTICE 2

1. Draw the next step suggested by this “connected” rectangle pattern. Then complete the table and find a rule for the number of toothpicks at step *x*.



Step # (*x*)	0	1	2	3	4	5	50	*x*
Number of toothpicks (*y*)								
Expression related to the rectangle picture								

2. Label the horizontal and vertical axes and graph the data points.



3. Finish the description:

   Use ______ toothpicks in Step 1, and then

   ___________ for each additional step.

4. Explain what operations are performed on the input value (step #) to arrive at the corresponding output value (number of toothpicks).

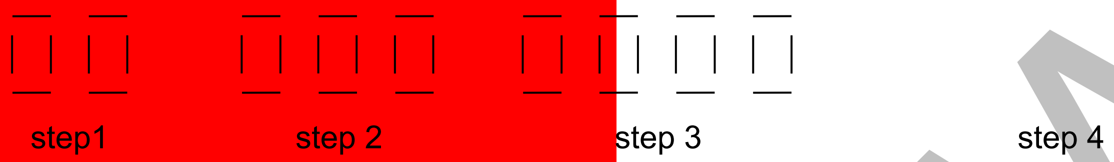
   Equation (input-output rule):

5. How many toothpicks are in step 100?

6. Which step number has exactly 58 toothpicks?

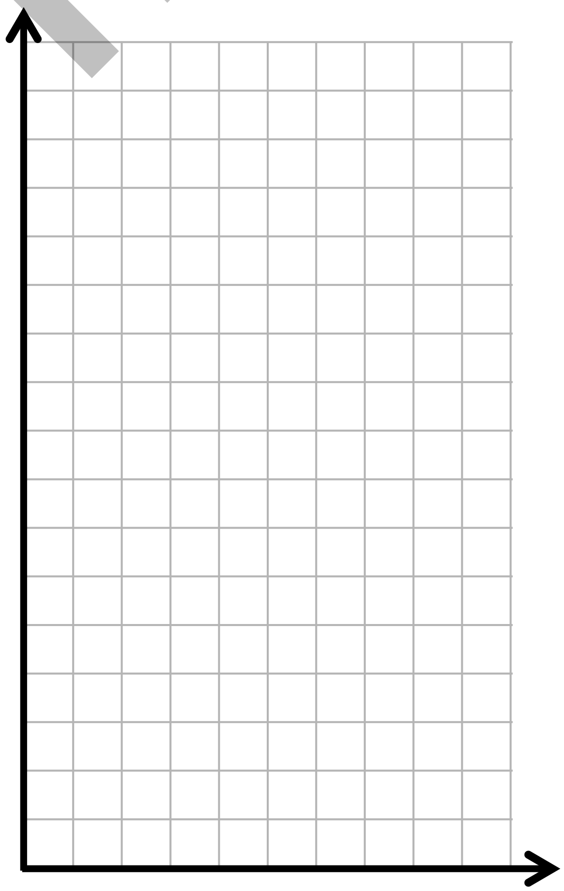
PRACTICE 3

1. Draw the next step suggested by this “unconnected” rectangle pattern. Then complete the table and find a rule for the number of toothpicks at step *x*.



Step # (*x*)	0	1	2	3	4	5	50	*x*
Number of toothpicks (*y*)								
Expression related to the rectangle picture								

2. Label the horizontal and vertical axes and graph the data points.



3. Finish the description:

Use _____ toothpicks in Step 1, and then

__________ for each additional step.

4. Explain what operations to perform on the input value (step #) to arrive at the corresponding output value (number of toothpicks).

Equation (input-output rule):

5. How many toothpicks are in step 100?

6. Which step number has exactly 96 toothpicks?

BEST BUY PROBLEMS

We will use tables and graphs to help determine which choices are better buys, based on price. We will examine proportional relationships.

GETTING STARTED

You are running out of your favorite pens and pencils. Compare prices at two stores before making a purchase.

VALUE-MART	SAVINGS HUT
Pens: 6 for $7.50	Pens: 6 for $8.25
Pencils: 12 for $6.80	Pencils: 14 for $6.80

1. At which store are pens cheaper? Explain.

2. At which store are pencils cheaper? Explain.

BAGELS

Follow your teacher's directions to complete this page.

SHMEAR 'N THINGS

HOLE-Y BREAD

PRACTICE 4

FLAT 'N ROUND
3 tortillas for $0.60

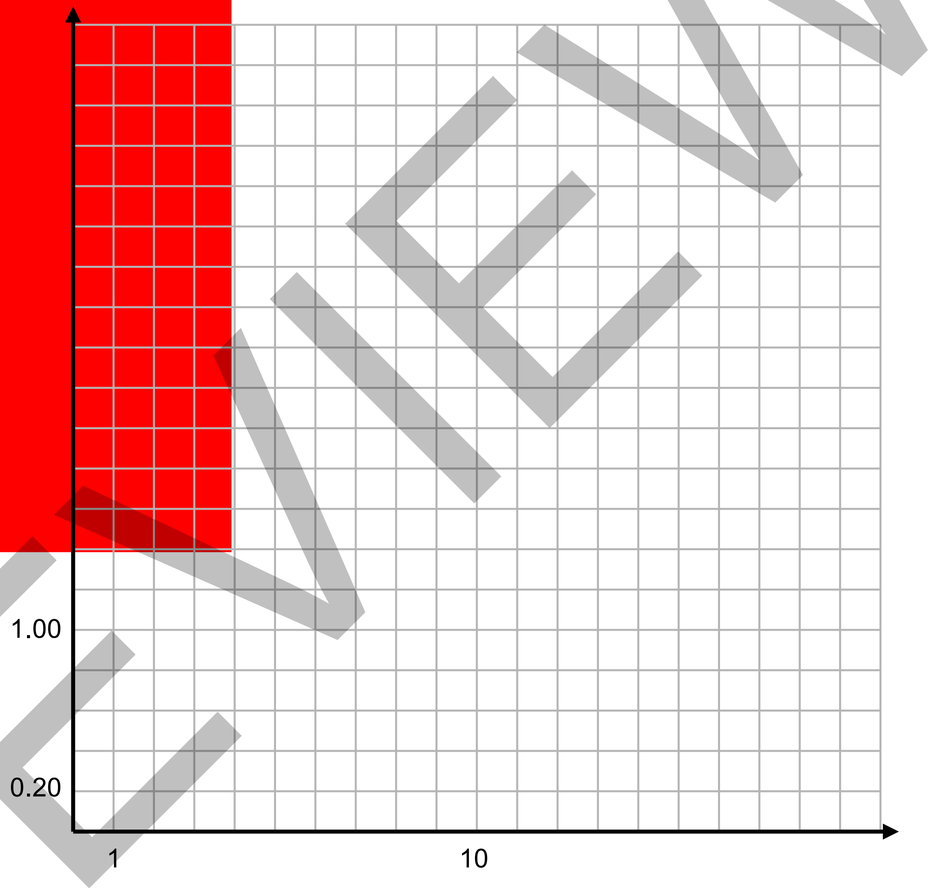
WRAP IT UP
4 tortillas for $1.00

Assume a proportional relationship between the number of tortillas and cost.

1. Fill in the tables and graph the data below. Be sure to label the axes.

FLAT 'N ROUND	
# of tortillas (*x*)	cost in $ (*y*)
3	
6	

WRAP IT UP	
# of tortillas (*x*)	cost in $ (*y*)
4	
8	



2. Complete the table.

	Unit price	Equation
FLAT 'N ROUND		
WRAP IT UP		

3. I know the better buy can be made at _______________ because:

4. Both graphs go through (0, 0). Explain what this ordered pair means in the context of this problem.

PRACTICE 5

PAPA'S PITA
6 pitas for $_____

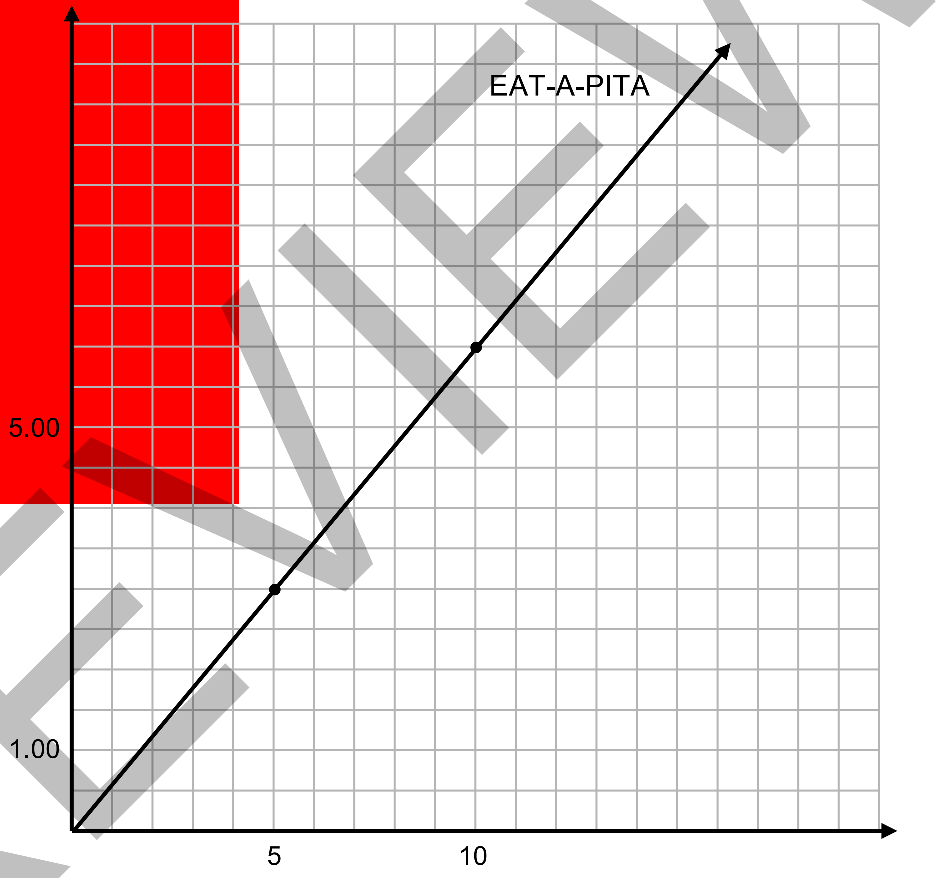
EAT-A PITA
10 pitas for $_____

Use the information from the table and the graph below to complete this page. Assume a proportional relationship between the number of tortillas and cost.

1. Fill in the tables and graph the data below. Be sure to title the graph and label the axes.

PAPA'S PITA	
# of pitas (*x*)	cost in $ (*y*)
2	1

EAT-A PITA	
# of pitas (*x*)	cost in $ (*y*)



2. Complete the table.

	Unit price	Equation
PAPA'S PITA		
EAT-A PITA		

3. I know the better buy can be made at _______________ because:

4. The graph for Eat-a-Pita goes through (1, _____). Explain what this ordered pair means in the context of this problem.

REVIEW

SAVING FOR A VIDEO GAME CONSOLE

Maricela needs $275 to buy her favorite video game console. She already has $125 saved. She can save $15 per month, but if she really sacrifices, she thinks she can save more aggressively at the rate of $30 per month. Compare **both** saving situations:

1. Make tables with several entries for each situation. Be sure to label both clearly.
2. Graph the data from both tables. Be sure to label and scale the graph clearly.
3. Write an equation for both situations.
4. State how long it will take her to save the required amount for both situations.

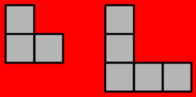
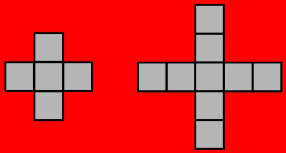
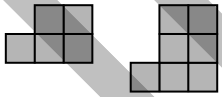
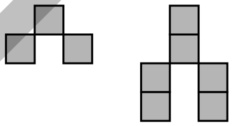
POSTER PROBLEM: GEOMETRIC PATTERNS

Part 1: Your teacher will divide you into groups.

- Identify members of your group as A, B, C, or D.
- Each group will start at a numbered poster. Our group start poster is ________.
- Each group will have a different colored marker. Our group marker is __________.

Part 2: Do the problems on the posters by following your teacher's directions.

Steps 1 and 2 of each pattern are given below.

Poster 1 (or 5)	Poster 2 (or 6)	Poster 3 (or 7)	Poster 4 (or 8)
			

A. Copy steps 1 and 2 onto the poster and draw step 3.

B. Make a table, label it appropriately, and record values for steps 0 through 5.

C. Make a graph and label it appropriately.

D. Write an equation that relates the total number of squares to the step number.

Part 3: Return to your seats. Work with your group, and show all work.

Use your "start problem."

1. Find the number of squares in step 100.

2. Find which step number has exactly 105 squares.

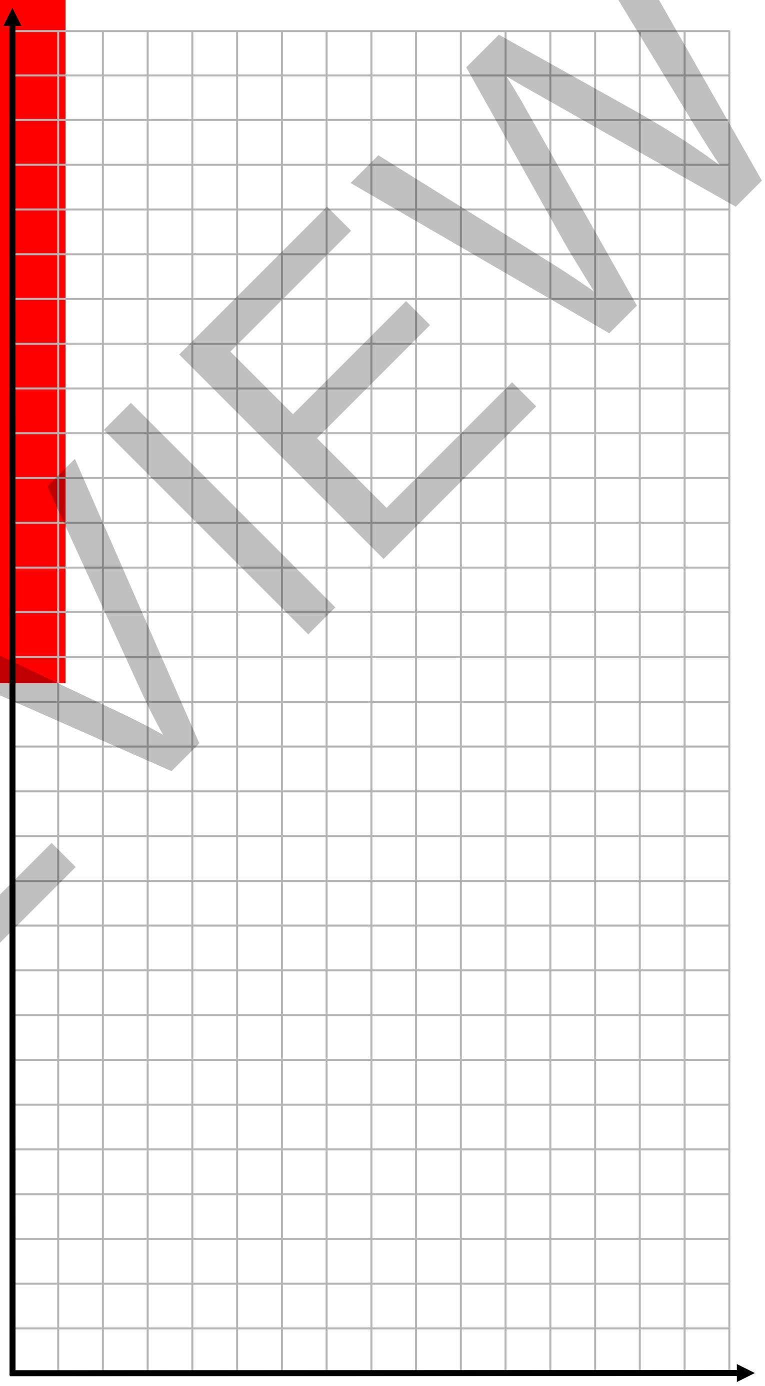
MATCHING ACTIVITY: BEST BUY

1. Your teacher will give you some cards. Match cards to their equivalent representations.

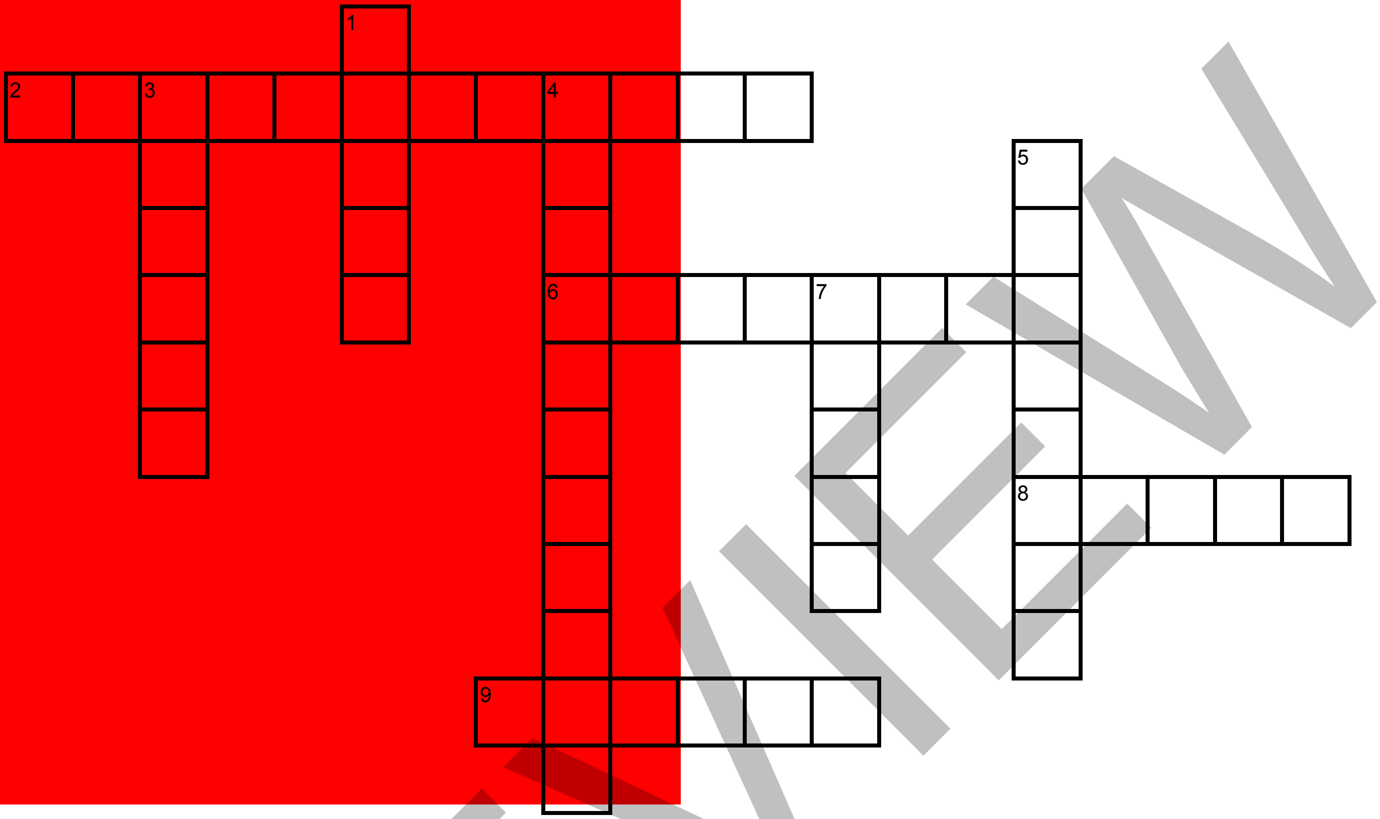
2. Explain which store represents the best buy. Use information from the cards and the graph to support your answer.

3. Explain which store represents the worst buy. Use information from the cards and the graph to support your answer.

4. Explain where the unit rates are seen in the equation and on the graph.



VOCABULARY REVIEW



Across

2 A relationship when one variable is a multiple of another.

6 A statement where two expressions are equal.

8 For a linear function in the form $y = mx + b$, x is considered the _____ value.

9 A function in form $y = mx + b$ (it's graph is a line).

Down

1 The _____ of a linear function is a line on the coordinate plane.

3 For a linear function in the form $y = mx + b$, y is considered the _____ value.

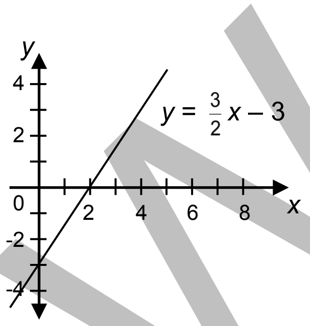
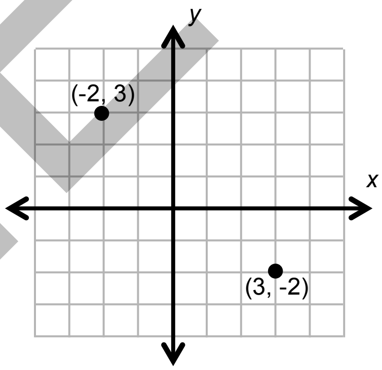
4 (3, 5) is an example of an _____ _____ (two words).

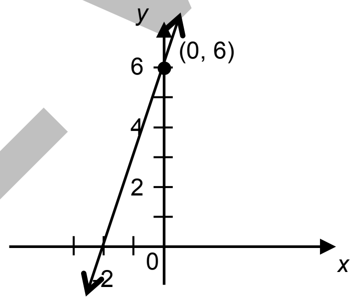
5 A rule that assigns to each input value exactly one output value.

7 We use a _____ with rows and columns as a way to organize numbers.

DEFINITIONS, EXPLANATIONS, AND EXAMPLES

<table>
<tr><th>Word or Phrase</th><th>Definition</th></tr>
<tr><td>coefficient</td><td>A <u>coefficient</u> is a number or constant factor in a term of an algebraic expression.
In the expression $3x + 5$, 3 is the coefficient of the term $3x$, and 5 is the constant term.</td></tr>
<tr><td>constant term</td><td>A <u>constant term</u> in an algebraic expression is a term that has a fixed numerical value.
In the expression $5 + 12x – 7$, 5 and -7 are constant terms.</td></tr>
<tr><td>equation</td><td>An <u>equation</u> is a mathematical statement that asserts the equality of two expressions.
$18 = 8 + 10$ is an equation that involves only numbers.
$18 = x + 10$ is an equation that involves numbers and a variable.
$y = x + 10$ is an equation that involves a number and two variables.</td></tr>
<tr><td>expression</td><td>A mathematical <u>expression</u> is a combination of numbers, variables, and operation symbols. When values are assigned to the variables, an expression represents a number.
Some mathematical expressions are $7x$, $a + b$, $4v – w$, and 19.</td></tr>
<tr><td>function</td><td>A <u>function</u> is a rule that assigns to each input value exactly one output value.
Consider the function $y = 3x + 6$. For any input value, say $x = 10$, there is a unique output value; in this case $y = 3(10) + 6$. Therefore the output value is 36.</td></tr>
<tr><td>input-output rule</td><td>An <u>input-output rule</u> for a sequence of values is a rule that establishes explicitly an output value for each given input value.
<table>
<tr><th>input value (x)</th><th>output value (y)</th></tr>
<tr><td>1</td><td>4</td></tr>
<tr><td>2</td><td>10</td></tr>
<tr><td>3</td><td>16</td></tr>
<tr><td>4</td><td>22</td></tr>
<tr><td>5</td><td>28</td></tr>
<tr><td>6</td><td>34</td></tr>
<tr><td>x</td><td>$6x – 2$</td></tr>
</table>
In the table above, the input-output rule could be $y = 6x – 2$. In other words, to get the output value, multiply the input value by 6 and subtract 2.
If $x = 5$, then $y = 6(5) – 2 = 30 – 2 = 28$.</td></tr>
</table>

Word or Phrase	Definition
linear function	A linear function (in variables *x* and *y*) is a function that can be expressed in the form *y* = *mx* + *b*. The graph of *y* = *mx* + *b* is a straight line with slope *m* and *y*-intercept *b*. The graph of the linear function $y = \frac{3}{2}x - 3$ is a straight line with slope $m = \frac{3}{2}$ and *y*-intercept *b* = -3. 
ordered pair	An ordered pair of numbers is a pair of numbers with a specified order. Ordered pairs are denoted (*a*, *b*), (*x*, *y*), etc. Ordered pairs of numbers are used to represent points in a coordinate plane. The ordered pair (3, -2) represents the point with *x*-coordinate 3 and *y*-coordinate -2. This is different from the ordered pair (-2, 3). 
proportional	Two quantities are proportional if one is a multiple of the other. We say that *y* is proportional to *x* if *y* = *kx*, where *k* is the constant of proportionality. If the cost for every 6 bagels is $3, then bagels and cost are in a proportional relationship. Let *x* = the number of bagels. Let *y* = the cost of bagels. Then *y* = 0.5*x* is an equation to determine the cost, given the number of bagels, and 0.5 is the constant of proportionality, which is also the cost in dollars for 1 bagel.
proportional relationship	Two variables are in a proportional relationship if the values of one are the same constant multiple of the values of the other. The constant is referred to as the constant of proportionality. If Wrigley eats 3 cups of kibble each day, then the number of cups of kibble and the number of days are in a proportional relationship.

Word or Phrase	Definition
unit price	A unit price is a price for one unit of measure. The unit price \$1.25 per pound can also be written $\frac{1.25\text{ dollars}}{1\text{ pound}}$ or $1.25\frac{\text{dollars}}{\text{pounds}}$ or \$1.25/lb.
unit rate	A unit rate is a rate for one unit of measure. The unit rate 80 miles per hour can be written $\frac{80\text{ miles}}{1\text{ hour}}$ or $80\frac{\text{miles}}{\text{hour}}$ or 80 mi/hr.
variable	A variable is a quantity whose value has not been specified. Variables are used in many different ways. They may refer to functions, to quantities that vary in a relationship, or to unknown quantities in equations and inequalities. In the equation $d = rt$, the quantities d, r, and t are variables. In the equation $2x + 4 = 10$, the variable x may be referred to as the unknown.
y-intercept	The *y*-intercept of a line is the *y*-coordinate of the point at which the line crosses the *y*-axis. It is the value of y that corresponds to $x = 0$. For the line $y = 3x + 6$, the *y*-intercept is 6. If $x = 0$, then $y = 6$. 

Using Multiple Representations to Describe Linear Functions

Here is a collection of four representations that might be used to approach a math problem:

- Numbers (numerical approach, as by making a table)
- Pictures (visual approach, as with a picture or graph)
- Symbols (algebraic approach, as with variables)
- Words (verbal approach to explain a strategy or a solution, orally or in writing)

Each approach may lead to a valid solution. Collectively they should lead to a complete and comprehensive solution, one that is readily accessible to more people and that provides more insight.

Hexagons are formed with toothpicks. Describe this "toothpick pattern" of hexagons using numbers, pictures, words, and symbols.

Numbers

Step #	number of toothpicks	Breaking apart numbers sometimes helps you see an input-output rule.	
1	6	6	= 6 + (0)5
2	11	6 + 5	= 6 + (1)5
3	16	6 + 5 + 5	= 6 + (2)5
4	21	6 + 5 + 5 + 5	= 6 + (3)5
5	26	6 + 5 + 5 + 5 + 5	= 6 + (4)5
x	5*x* + 1	5*x* + 1	= 6 + (*x* – 1)5

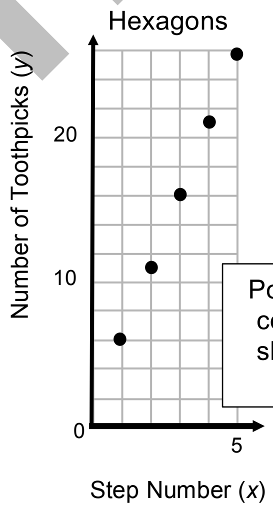
Words

One way to describe the hexagonal toothpick pattern is to start with 6 toothpicks and add 5 more toothpicks at each subsequent step. Notice that the number of 5's added at each step is equal to 1 less than the step number.

Symbols

A rule for finding the number of toothpicks at step x is $6 + (x - 1)5$, which can be simplified to $5x + 1$.

Pictures



Points may be connected to show a trend line.

Note: We consider a graph to be a picture.

Using Multiple Representations to Describe Linear Functions (Continued)

At Peter's Pitas, 4 pitas cost $1.00. At Petra's Pitas, 6 pitas cost $2.00. Assume a proportional relationship between the number of pitas and their cost. Use multiple representations to explore which store offers the better buy for pitas.

Numbers
(make a table)

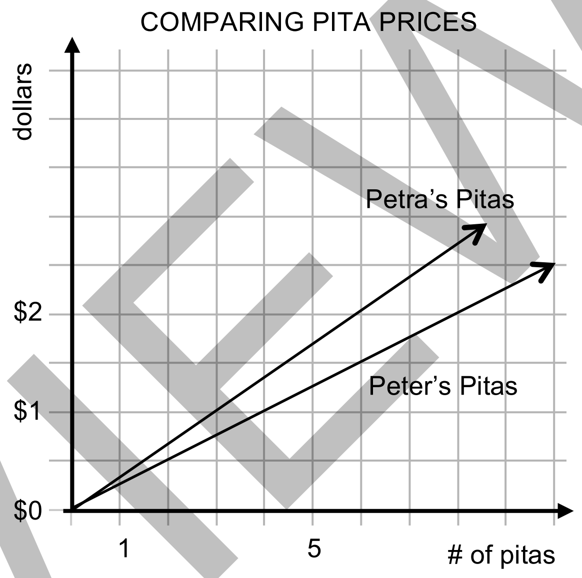
PETER'S PITAS

# of pitas (*x*)	cost (*y*)
4	$1.00
8	$2.00
2	$0.50
10	$2.50
1	$0.25

PETRA'S PITA

# of pitas (*x*)	cost (*y*)
6	$2.00
12	$4.00
3	$1.00
1	$0.33
2	$0.66

Pictures
(make a graph)



Words
(write sentences)

Possible statements are:

Based on the table, Peter's Pitas is the better buy.

At Peter's Pitas, you get 4 pitas for $1.00.
This means the unit price (cost for one pita) is $0.25.

At Petra's Pitas you get 6 pitas for $2.00. This means the unit price (cost for one pita) is approximately $0.33.

Symbols
(write equations to relate the number of pitas to cost)

PETER'S PITAS $y = 0.25x$

PETRA'S PITAS $y = 0.33x$

Notice that $0.25 is the cost of one pita at Peter's Pita. This corresponds to the point (1, 0.25) on the graph.

Notice that $0.33 is the cost of one pita at Petra's Pitas. This corresponds to the point (1, 0.33) on the graph.

The equations above are both in the form $y = mx$. This is called a direct proportion equation because y is directly proportional to (is a constant multiple of) x. Graphs of direct proportions are lines that pass through the origin.

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