Name ______________________________ Period __________ Date ______________

UNIT 6
STUDENT PACKET

MathLinks GRADE 7

EXPRESSIONS

Parent (or Guardian) signature ______________________________________

MY WORD BANK

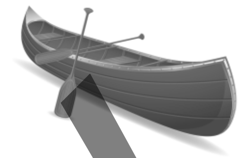
Explain the mathematical meaning of each word or phrase, using pictures and examples when possible. See **Student Resources** for mathematical vocabulary.

coefficient	equation
equivalent expressions	expression
input-output rule	proportional relationship
terms like terms	variable

OPENING PROBLEM: CROSSING THE LAKE

[SMP 1, 4, 5, 7, 8]

Follow your teacher's directions.



(1)

(2)

EXPRESSION INVESTIGATIONS

We will write numerical expressions to represent geometric patterns, describe patterns in words, and generalize these patterns using variable expressions. After working more with expressions, we will revisit **Crossing the Lake**.

[7.NS.3, 7.EE.3, 7.RP.2a, 7.EE.1, 7.EE.2, SMP1, 2, 3, 4, 6, 7, 8]

GETTING STARTED

1. Record the meanings of variable and expression in **My Word Bank**.

Rewrite each arithmetic problem below as an expression, horizontally on one line, which is more typical of what is done in algebra. Do not compute.

2.	3.	4.
23 46 + 54 ______	132 – 67 ______	$19\overline{)451}$ ______

5. Rewrite problem 4 using fraction notation.

Write a numerical or algebraic expression for each statement below. Do not compute.

6. a. There are 6 puppies and 8 kittens. Write a numerical expression for the total number of puppies and kittens. b. There are p puppies and k kittens. Write a variable expression for the total number of puppies and kittens.	7. a. Otis has 4 ribbons. Ella has 6 times as many ribbons as Otis. Write a numerical expression for the number of Ella's ribbons. b. Otis has n ribbons. Ella has 6 times as many ribbons as Otis. Write a variable expression for the number of Ella's ribbons.

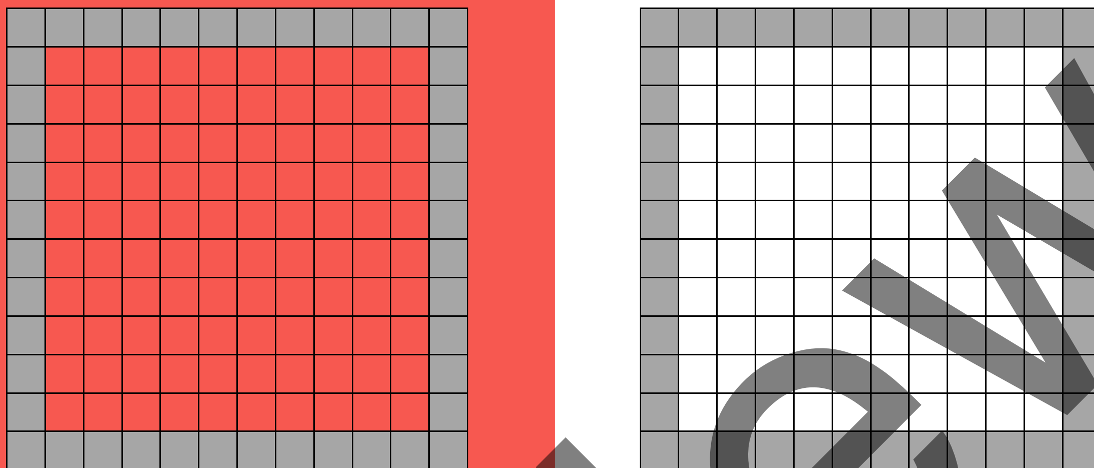
Rewrite each expression below using the distributive property and then simplify.

8. $3(v + 2) + 5(v + 4)$	9. $6(w – 1) + 4(w – 2)$

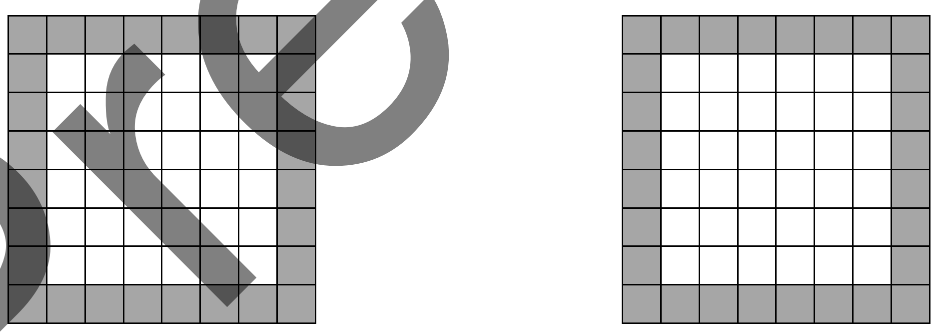
HOW MANY ON THE BORDER?

Follow your teacher's directions.

(1)



(2)



HOW MANY ON THE BORDER?

Continued

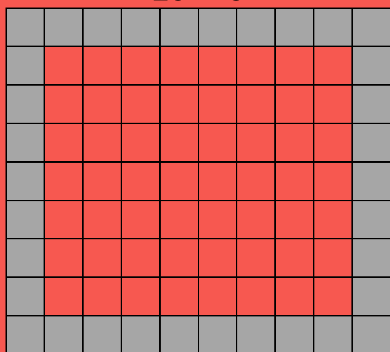
(3) Fill in the chart below as directed by your teacher.

	Emmett's sketch	Maya's sketch	Zara's sketch
(3abc) Row I 12×12			
(3d) Row II 8×8			
(3d) Row III 5×5			
(3e) Row IV $n \times n$			

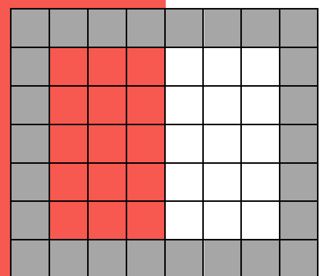
PRACTICE 1

1. Record the meaning of <u>equivalent expressions</u> in **My Word Bank**.
2. Draw sketches and write three numerical expressions for the number of shaded border squares in these gardens. Two of the gardens have been drawn for you.

10 × 9



8 × 7



5 × 4

	Numerical expressions for the gardens		
sketches	**10 × 9**	**8 × 7**	**5 × 4**
Evaluate the expressions to verify equivalence →			

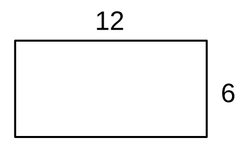
3. Consider the border pattern that seems to be established in the gardens above.

   If the longer side has length *n*, then the shorter side has length (____ – ____).

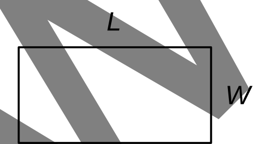
   Write at least two variable expressions for the number of shaded border squares and simplify them. Circle the simplified expressions to show that they are equivalent.

PRACTICE 2

1. For the 12×6 rectangle to the right, write at least two numerical expressions to represent its perimeter.



2. For the $L \times W$ rectangle to the right, write at least two variable expressions to represent its perimeter.



3. A rectangle is twice as long as it is wide. Let W represent the width, and L the length.

   a. Lena thinks that $2L = W$ is a true expression regarding this statement. Why is she incorrect?

   b. Rewrite a correct statement that relates L and W.

   c. Circle all the expressions below that represent the perimeter of the $L \times W$ rectangle above:

   $W + L + W + L$ $\quad$ $2W + 2L$ $\quad$ $2(W + L)$ $\quad$ $2W + L$

   $W + 2W + W + 2W$ $\quad$ $L + 2L + L + 2L$ $\quad$ $\frac{L}{2} + L + \frac{L}{2} + L$

4. Record the meanings of <u>term</u>, <u>like terms</u>, and <u>coefficient</u> in **My Word Bank**.

PRACTICE 3

1. Explain why $2n + 5$ and $2(n + 5)$ are NOT equivalent expressions.

2. Consider the algebraic expression $x + 3x + y + 2y + 5x$.

   a. Combine like terms to simplify the expression.

   b. Rewrite the expression as a product of 3 and the sum of two terms.

   3(_____ + _____)

   c. Substitute the values $x = -1$ and $y = -4$ into:

   The original expression

   The expression in part a

   The expression in part b

   d. Why are all the expressions equivalent?

PAINTINGS ON THE WALL

Jayy has a room with a wall that is $12\frac{1}{4}$ feet wide.

- Jayy wants to paint four square canvases that are all the same size to hang side-by-side across the wall from left to right, and wants to know what size canvases to buy.
- Jayy wants $\frac{3}{4}$ feet between each of the four canvases.
- Jayy wants to leave $1\frac{1}{4}$ feet between the left edge of the wall and the first canvas and $1\frac{1}{4}$ feet between the right edge of the wall and the last canvas.

1. Sketch and label Jayy's wall with the four canvases on it. Then find the side length for each square canvas.

2. Jayy's friends like the way the wall looks with the canvases on it and want to do exactly the same on their walls, but the total wall width for each of them is different.

   a. Write an expression Jayy could share for the side length they should use for their square canvases using a wall width of w feet.

   b. If a friend determines he will buy square canvases with side lengths equal to 1 foot, how long is his wall?

PRACTICE 4

Let the variable n represent some number. Match the expression with the word descriptions. Some may be used more than once. Some may not be used at all.

______	1.	5 less than twice a number	a.	$2n + 5$
______	2.	5 more than twice a number	b.	$2 \bullet \frac{n}{5}$
______	3.	5 times a number, increased by 2	c.	$-2n - 5$
______	4.	5 times a number, decreased by 2	d.	$-2 \bullet \frac{n}{5}$
______	5.	2 subtracted from the product of a number and 5	e.	$5n - 2$
______	6.	Twice the quotient of a number and 5	f.	$5n + 2$
______	7.	Twice the sum of a number and 5	g.	$-(n - 5)$
______	8.	Twice a number, increased by 5	h.	$5(2n)$
______	9.	The opposite of twice a number, decreased by 5	i.	$2(n + 5)$
______	10.	The opposite of the difference when twice a number is decreased by 5	j.	$5(n - 2)$
______	11.	The opposite of 5 less than a number	k.	$2n - 5$
______	12.	The opposite of twice the quotient of a number and 5	l.	$-(2n - 5)$

CROSSING THE LAKE REVISITED

1. Review your work and notes from the opening problem. Do you see any patterns? Does anything seem to be happening regularly, over and over again? Circle a repeating pattern if you see one. Write your observations below.

2. Write a numerical expression that represents the number of one-way trips it takes for 6 adults and 2 children to cross the lake.

_____ • _____ + _____

For problems 3 – 8, write each as an expression in the form of problem 2 above. Use your diagram as needed to determine the number of one-way trips necessary to get each combination of people across the lake.

3. 4 adults and 2 children	4. 2 adults and 2 children	5. 0 adults and 2 children
6. 20 adults and 2 children	7. 100 adults and 2 children	8. *n* adults and 2 children

9. Explain the meaning of the expression in problem 8 above.

10. Assume the number of children remains 2.

    a. If the number of adults is doubled, are the number of trips doubled?

    b. If the number of adults is multiplied by 5, are the number of trips multiplied by 5?

    c. Record the meaning of proportional relationship in **My Word Bank**.
    Does the crossing the lake scenario represent a proportional relationship?

11. Suppose it takes some adults and 2 children a minimum of 201 one-way trips to get everyone across the lake. How many adults are in the group?

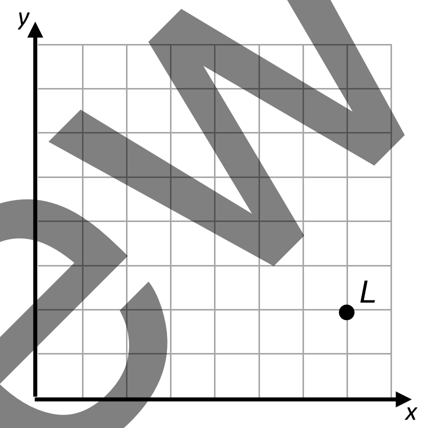
VISUAL PATTERNS

We will use words, tables of numbers, graphs, and equations (input-output rules) to describe visual patterns.

[7.EE.1, 7EE.2, 7.RP.2a; SMP2, 6, 8]

GETTING STARTED

Each small square on the grid to the right represents 1 square unit. As an example, the ordered pair (7, 2) is graphed and labeled point *L*.



1. Graph and label the following ordered pairs.

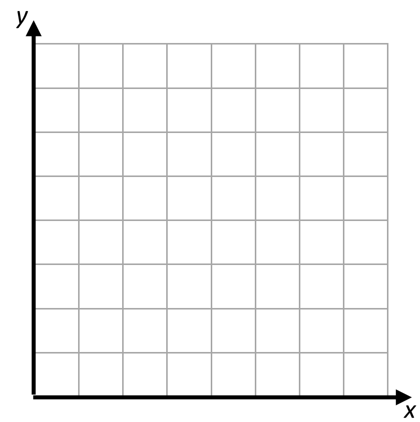
   A (0, 0) *B* (4, 4) *C* (1, 5) *D* (5, 1)

   E (3, 0) *F* (0, 3) *G* (8, 6) *H* (6, 8)

2. How can you remember that we count the *x*-coordinate horizontally first and the *y*-coordinate vertically second when graphing ordered pairs?

Use the word list below to fill in the blanks. Some words are used more than once. Use the coordinate plane below for reference or notes.

coordinate plane	horizontal	ordered pairs	origin	vertical



3. A __________ __________ is a plane with a horizontal axis and a vertical axis meeting at the point (0, 0), called the __________.

4. The __________ axis is typically referred to as the *x*-axis.

5. The __________ axis is typically referred to as the *y*-axis.

6. Points in the coordinate plane are named by pairs of numbers called __________ __________. They are written in the form (*x*, *y*).

7. From the origin to the point located at (3, 5), move 3 units in the __________ direction and 5 units in the __________ direction.

WHAT COMES NEXT?

Follow your teacher's directions.

(1)

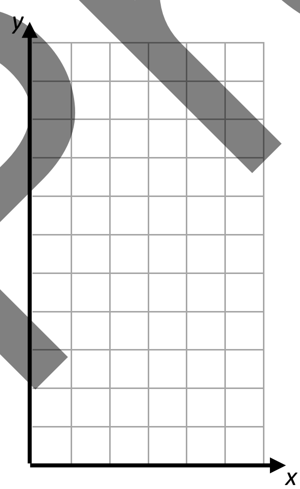
Dion

(2) Picture

(3) Table

1	
2	
3	
4	
5	

(4) Graph



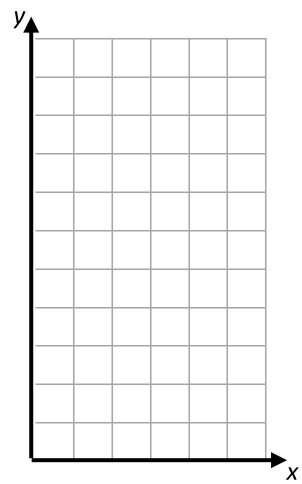
Mateo

(2) Picture

(3) Table

1	
2	
3	
4	
5	

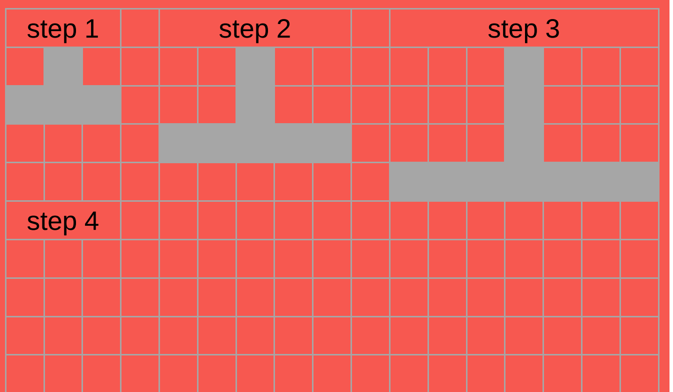
(4) Graph



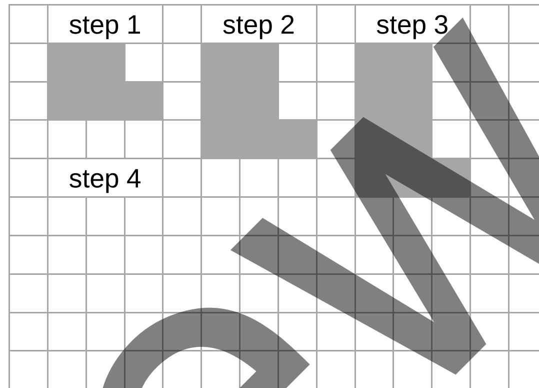
PRACTICE 5

1. Build steps 1 – 3 for tile patterns A and B. Then build and draw step 4 for each pattern. Complete the tables and draw the graphs with titles and labels.

Tile Pattern A

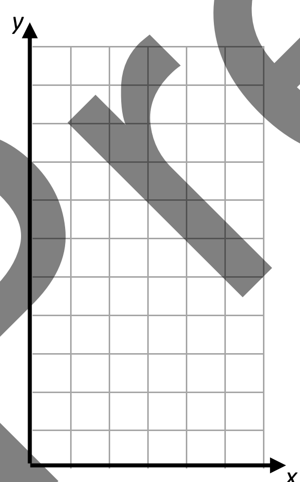


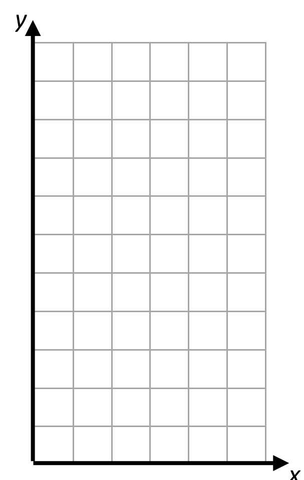
Tile Pattern B



1	
2	
3	
4	
5	

1	
2	
3	
4	
5	





2. Why are neither of these relationships proportional?

INPUT-OUTPUT RULES

Follow your teacher's directions for (1) – (4).

(1)	(2)
(3)	(4)

Fill in missing numbers and blanks based on the suggested numerical patterns. In the tables below, the *x*-value is considered the input value and the *y*-value is the output value.

5.

x	1	2		4		6
y	5	9	13		21	

a. Rate of change: for every increase of *x* by 1, *y* increases by ___.

b. Input-output rule (words): multiply the *x*-value by ___, then add ___ to get the corresponding *y*-value.

c. Input-output rule (equation): *y* = __________

6.

x	1		3		5	6
y	3	7		15		23

a. Rate of change: for every increase of *x* by 1, *y* increases by ___.

b. Input-output rule (words): multiply the *x*-value by ___, then subtract ___ to get its corresponding *y*-value.

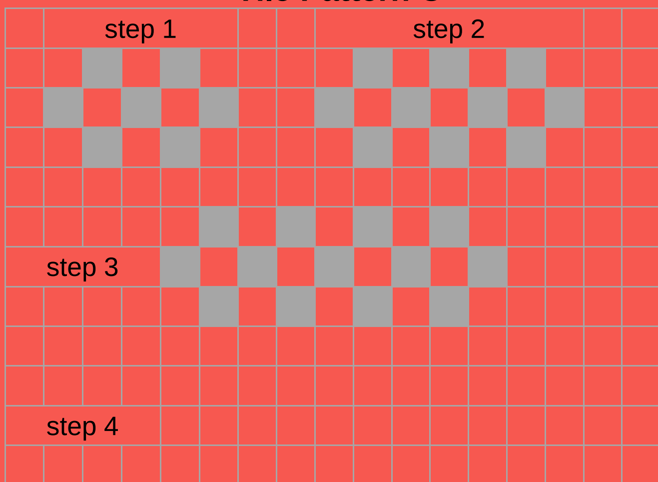
c. Input-output rule (equation): *y* = __________

7. Record the meanings of equation and input-output rule in **My Word Bank**.

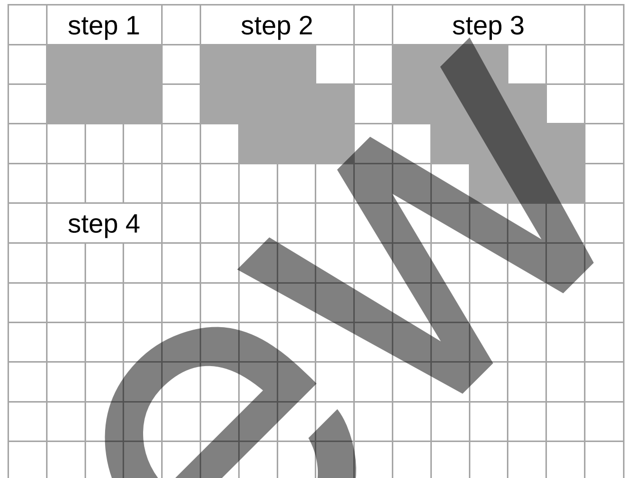
PRACTICE 6

1. Build steps 1 – 3 for tile patterns C and D. Then build and draw step 4 for each pattern. Complete the tables and draw the graphs with titles and labels.

Tile Pattern C

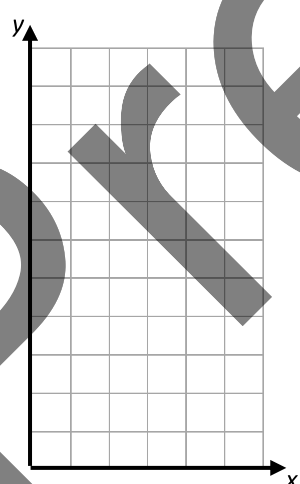


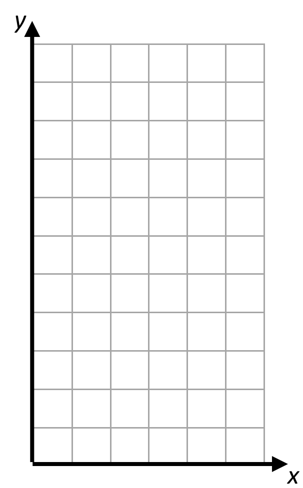
Tile Pattern D



1	
2	
3	
4	
5	

1	
2	
3	
4	
5	





Rule for C: ___________

Rule for D: __________

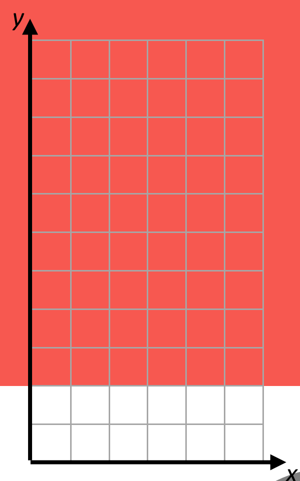
2. True or false: For these patterns, the step number is the input value.

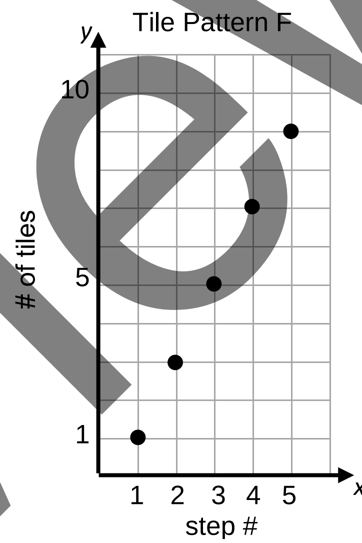
PRACTICE 7

1. Pattern E is described with a table. Pattern F is described with a graph. Complete the other representations.

Tile Pattern E	
step # (*x*)	**# of tiles (*y*)**
1	2
2	5
3	8
4	11
5	14

1	
2	
3	
4	
5	





Rule for E: ___________

Rule for E: ___________

Tile Pattern E

Tile Pattern F

2. Write the increase in number of tiles for each step for each pattern. E: _____ F: _____

3. True or false: For these patterns, the step number is the output value.

PRACTICE 8: EXTEND YOUR THINKING

1. Fill in the chart below based upon the work you did previously for tile patterns A – F.
   - Column I: Copy each rule (make sure you have the correct rules before proceeding)
   - Columns II-IV: Find the numbers of square tiles for the given step numbers
   - Column V: Find each step number for the given number of square tiles

I	II	III	IV	V
Pattern	**Step 10**	**Step 100**	**Step 1,000**	**Step Number**
A →				for 61 tiles
B →				for 403 tiles
C →				for 9,004 tiles
D →				for 202 tiles
E →				For 26 tiles
F →				for 9,999 tiles

2. Complete the table below and fill in the blanks.

a.

x	1	2	3	4	5	6	8	11	12
y	$1\frac{1}{2}$	$3\frac{1}{2}$	$5\frac{1}{2}$	$7\frac{1}{2}$	$9\frac{1}{2}$				$23\frac{1}{2}$

b. Rate of change: for every increase of x by 1, y increases by _____.

c. Input-output rule (words): Multiply an x-value by _____ and subtract _____ to get the corresponding y-value.

d. Input-output rule (equation): $y =$ ____ • $x -$ ____

e. If $x = 100$, then $y =$ _______.

f. If $y = 99\frac{1}{2}$, then $x =$ _______.

EXPRESSIONS WITH CUPS AND COUNTERS

We will introduce a model and use it for building, drawing, and rewriting expressions that have integers as constants and coefficients.

[7.EE.1; SMP3, 5, 6]

GETTING STARTED

Match each expression in Column I with an equivalent expression in Column II.

	Column I		Column II
1. ______	$4 + 4$	a.	$x - 4$
2. ______	$4 + (-4)$	b.	$x - (-x)$
3. ______	$x + 4$	c.	$4 - 4$
4. ______	$x + (-4)$	d.	$x - x$
5. ______	$x + x$	e.	$x - (-4)$
6. ______	$x + (-x)$	f.	$4 - (-4)$

7. Problems 1 – 6 illustrate an important relationship between addition and subtraction:

   Subtracting a number gives the same result as…

8. Evaluate $x + 4x + 6 + 3x - 8 - 7x + 2 - x$ when…

a. $x = 20$	b. $x = 2$	c. $x = -2$

INTRODUCTION TO CUPS AND COUNTERS

Follow your teacher's directions for (1) – (8).

(1)

Positive Counter	**Negative Counter**	**Cup**

(2)	(3)	(4)
(5)	(6)	(7)
(8)		

Build and draw the following expressions.

9. $2x + 1$	10. $x - 4$	11. $2x - 4$

Write variable expressions for the following.

12. **V + + +**	13. **V V**	14. **V V – –**

15. In problem 8 above, we see that $3(x + 2)$ is equivalent to $3x + 6$. Verify that these two expressions have the same value:

a. when $x = 4$:

b. when $x = -4$:

THE UPSIDE-DOWN CUP

Follow your teacher's directions for (1) – (11).

(1)

Cup	Upside-Down Cup

(2)	(3)	(4)	(5)

(6)	(7)

(8)	(9)
(10)	(11)

Write each expression below as a sum of terms in simplest form. Build and draw if helpful.

12. $-x + 2x - 3 - x$	13. $-3(3x - 1)$	14. $4 - (x + 2)$

Evaluate each expression below involving the cup that represents the unknown (x).

	∨	∨ ∨	∧	∧ + +	∧ ∧	∧ – – –
15.	4					
16.		-12				
17.			0			
18.					$-2x$	

PRACTICE 9

Simplify each expression. Use cups and counters or a picture as needed.

1. $3x - x - 5x - 4$	2. $3 - 1 - 5 - 4x$
3. $3x + 6 + x - 6$	4. $-x - 5x - 5 + 1$

5. Apply the distributive property to each expression below. Use cups and counters or a picture as needed. Then match each expression in Row I to an equivalent expression in Row II as a check.

Row I	a. $2(x + 1)$	b. $2(x - 1)$	c. $2(-x + 1)$	d. $2(-x - 1)$
Row II	e. $-2(x + 1)$	f. $-2(x - 1)$	g. $-2(-x + 1)$	h. $-2(-x - 1)$

6. Evaluate the expressions from above as directed.

Let $x = 5$	Let $x = -5$	Let $x = 10$	Let $x = -10$
a:	b:	c:	d:
its match:	its match:	its match:	its match:

7. Aretha looked at the expressions $2n$ and $n + 2$. She substituted the value of 2 for n in both expressions, and said, "They're both equal to 4, so they must be equivalent expressions." Critique Aretha's reasoning.

FLUENCY WITH EXPRESSSIONS

We will simplify and evaluate expressions with rational coefficients. We will create variable expressions to solve problems.

[7.RP.3, 7.NS.3, 7.EE.1, 7.EE.2, 7.EE.3; SMP2, 3, 4, 8]

GETTING STARTED

Use the distributive property to rewrite each numerical expression below so that it is a sum (or difference) of terms.

1. (9 + 5)(-3)	2. (9 – 5)(-3)	3. (-9 + 5)(3)	4. (-5 – 9)(3)

5. Equivalent expressions: problems ___ and ___; problems ___ and ___.

Use the distributive property to rewrite each variable expression below so that it is a sum (or difference) of terms.

6. $(-p - m)(h)$	7. $(-m + p)(h)$	8. $(m + p)(-h)$	9. $(m - p)(-h)$

10. Equivalent expressions: problems ___ and ___; problems ___ and ___.

Build and draw each expression below with cups and counters **and also** simplify the expressions algebraically to check if the results match.

11. $-3x - 4 - 3(1 - 2x)$		12. $-5x + 6 - (2 - 4x)$	
picture	**algebra procedure**	**picture**	**algebra procedure**

EXPRESSION CARD SORT…AND MORE

1. Your teacher will give you card set 1 – 3 and card set A – O. Each number card has some letter card matches, and there will be some letter cards left over. List the matching letter cards for each.

Card 1:	**Card 2:**	**Card 3:**	**No match:**

2. Circle all expressions that are equivalent to $9 - 5(6 - 2n)$.

$4(6 - 2n)$	$-21 - 2n$	$9 - 30 - 2n$	$9 - 30 - 10n$
$9 - 5(4n)$	$9 - 56 - 2n$	$9 - 30 + 10n$	$9 - 30 + 2n$

3. Circle all expressions that are equivalent to $m - 3(4 - m)$.

$m - 12 - m$	$m - 12 - 3m$	$m - 12 + 3m$	$4m - 12$
$2m - 12$	$m - 2(6 - m)$	$m - (12 - 3m)$	$m + [-3(4 - m)]$

4. Choose all expressions that could go in the blank. $4(w + 2) - 6(w - 1) =$ ______ $- 8(w + 2)$.

$-6w + 2$	$6w + 2$	$6w + 30$	$2(3w + 1)$
$10w + 2$	$6(w + 5)$	$-2(3w + 1)$	$2(5w + 1)$

5. Some students are trying to simplify the expression 7 – 2(3 – 8x). Describe each student's mistake.

a. Ray's work:	b. Nat's work:	c. Bo's work:
5(3 – 8x)	7 – 2(-5x)	7 – 6 – 16x

REWRITING EXPRESSIONS WITH FRACTIONS

Apply the distributive property to each expression below.

1. $\frac{3}{4}(u - v)$	2. $-\frac{3}{4}(u + v)$	3. $-\frac{2}{3}(u - \frac{1}{2})$	4. $-\frac{2}{3}(u - \frac{1}{2}v)$

Simplify each expression below by combining like terms.

5. $\frac{1}{4}x + \frac{1}{2}y - \frac{3}{4}x$	6. $-\frac{2}{3}x - 1\frac{3}{5}v - \frac{1}{6}x$
7. $-1\frac{3}{4}p - 2m - p - \frac{3}{4}m$	8. $-\frac{1}{4}(p - n) + \frac{3}{4}(p + n)$
9. $-2\frac{1}{2}v - (\frac{5}{9}y - 1\frac{1}{8}v)$	10. $-1\frac{1}{2}(-n - m) - \frac{1}{2}(n + \frac{1}{2}m)$

11. Circle all the expressions below that are equivalent to $\frac{-4x}{6} - \frac{4}{6}$.

$\frac{-4x - 4}{6}$ $\frac{-4(x + 1)}{6}$ $\frac{-2x}{3} - \frac{2}{3}$ $\frac{-2(x + 1)}{3}$

REWRITING EXPRESSIONS WITH DECIMALS

Apply the distributive property to each expression below.

1. $-0.5(d + k)$	2. $-0.5(2d + 0.1k)$	3. $2.5(-4d - k)$	4. $-1.2(0.4d - 3k)$

Simplify each expression below by combining like terms.

5. $2.4x + 3.5y - 1.8x$	6. $-2.4x - 3.5v - 1.8x$
7. $-0.6p - 1.3m - p - 2m$	8. $-2.6(p - n) + 3.9(p + n)$
9. $-2.4v - (3.5y - 1.8v)$	10. $-0.4(-n - m) - 1.4(n + 2m)$

11. Circle all the expressions below that are equivalent to $\dfrac{-2.2(x + 0.1)}{5}$.

$\dfrac{-2.2x - 2.2}{5}$ $\dfrac{-2.2(x)}{2} + \dfrac{-2.2(0.1)}{3}$ $\dfrac{-2.2x - 0.22}{5}$ $-\dfrac{2.2x}{5} - \dfrac{0.22}{5}$

PRACTICE 10

Simplify by combining like terms.

1. $(-2\frac{7}{10}v) - (\frac{9}{10} - 0.5v)$	2. $-\frac{5}{2}(2a + 2b) + \frac{5}{4}b$
3. $-2 + 1.5(f - \frac{1}{4}h)$	4. $2(-m + 1.5\,n) - \frac{1}{4}m$

5. Smokey and Richard were having a difficult time rewriting some expressions. Fix each of their common mistakes.

Smokey's expression: $\frac{-4x - 1}{6}$	Richard's expression: $\frac{2x - 2}{10}$
His mistaken rewrite: $\frac{-2x}{3} - 1$	His mistaken rewrite: $\frac{x-1}{5} + \frac{x-1}{5}$
Fix:	Fix:

6. Circle all the expressions that are equivalent to $5 + \frac{1}{2}(x + 8)$.

$5\frac{1}{2}(x + 8)$ $\frac{1}{2}x + 9$ $\frac{1}{2}x + 13$ $5 + \frac{1}{2}x + 4$

7. Circle all the expressions that are equivalent to $\frac{-4(-2x - 0.6)}{8}$.

$-\frac{1}{2}[(-2x - 0.6)]$ $\frac{8x + 2.4}{8}$ $\frac{8x}{8} + \frac{2.4}{8}$ $x + \frac{24}{80}$

TROUSERS FOR SALE

Jo hears that a popular brand of trousers is going on sale at two different stores, but is not sure if thetrousers are affordable. Here is what Jo observes as several days pass:

	Trouser Trove	Truly Trousers
Monday	regular price	regular price
Tuesday	25% off	10% off
Wednesday	another 25% off	another 20% off
Friday	another 25% off	another 30% off
Sunday	another 25% off	another 40% off

On Sunday, Jo says, "I'm getting those pants now, because they are $0 at both stores."

1. What is Jo's mistaken reasoning?

2. Find the price each day at both stores. The regular price is shown. Circle the better buys.

	Trouser Trove		Truly Trousers	
	denim	**corduroys**	**denim**	**corduroys**
Monday	$40	$60	$40	$60
Tuesday				
Wednesday				
Friday				
Sunday				

TROUSERS FOR SALE
Continued

3. Write an expression for the Sunday price for any pair of trousers at each store below. Let x equal the cost of the trousers in dollars.

a. Trouser Trove	b. Truly Trousers

4. There are other styles on these same sales. Use the expressions from problem 3 to find the Sunday price for each price below.

a. $20 shorts at Trouser Trove	b. $20 shorts at Truly Trousers
c. $80 fancy plaid at Trouser Trove	d. $80 fancy plaids at Truly Trousers

REVIEW

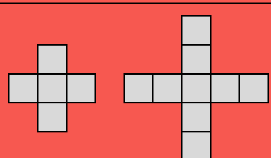
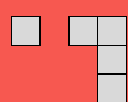
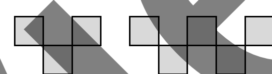
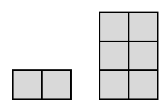
POSTER PROBLEMS: EXPRESSIONS

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. Explain your step 3 in words.

B. Make a table, label it appropriately, and record values for steps 1 through 5.

C. Make a graph and label it appropriately.

D. Write an input-output rule that relates the total number of tiles 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 tiles in step 100.

2. Circle your start poster below. Find which step number has exactly that number of tiles.

   1 (or 5) → 161 tiles

   2 (or 6) → 88 tiles

   3 (or 7) → 101 tiles

   4 (or 8) → 98 tiles

EXPRESSION GAME

Play five rounds to see who gets the most wins. Record each round in the table below.

1. **Player 1** rolls a number cube for an expression below.

If →	⚀	⚁	⚂	⚃	⚄	⚅
Then →	$-2x - 4$	$-2(x - 4)$	$4x + 2$	$4(x + 2)$	$-3(x + 1)$	$-3x + 1$

2. **Player 2** rolls for an expression below.

If →	⚀	⚁	⚂	⚃	⚄	⚅
Then →	$-x - 3$	$-(x - 3)$	$5(x - 1)$	$-5(x - 1)$	$-6x + 4$	$6(-x + 4)$

3. **Both** players add these two expressions to get a sum. Use extra paper if needed. Check that you both agree!

4. **Both** players roll for their own *x*-value below.

If →	⚀	⚁	⚂	⚃	⚄	⚅
Then →	$x = 1$	$x = 2$	$x = 3$	$x = -1$	$x = -2$	$x = -3$

5. Players substitute their own *x*-value into the expression sum and evaluate. Use your own paper if needed.

6. The player with the greater value in step 5 wins the round.

	Round 1	**Round 2**	**Round 3**	**Round 4**	**Round 5**
Expression Player 1					
Expression Player 2					
Expression Sum					
My *x*-value					
Substitute and evaluate					
Winner					

WHY DOESN'T IT BELONG?: EXPRESSIONS

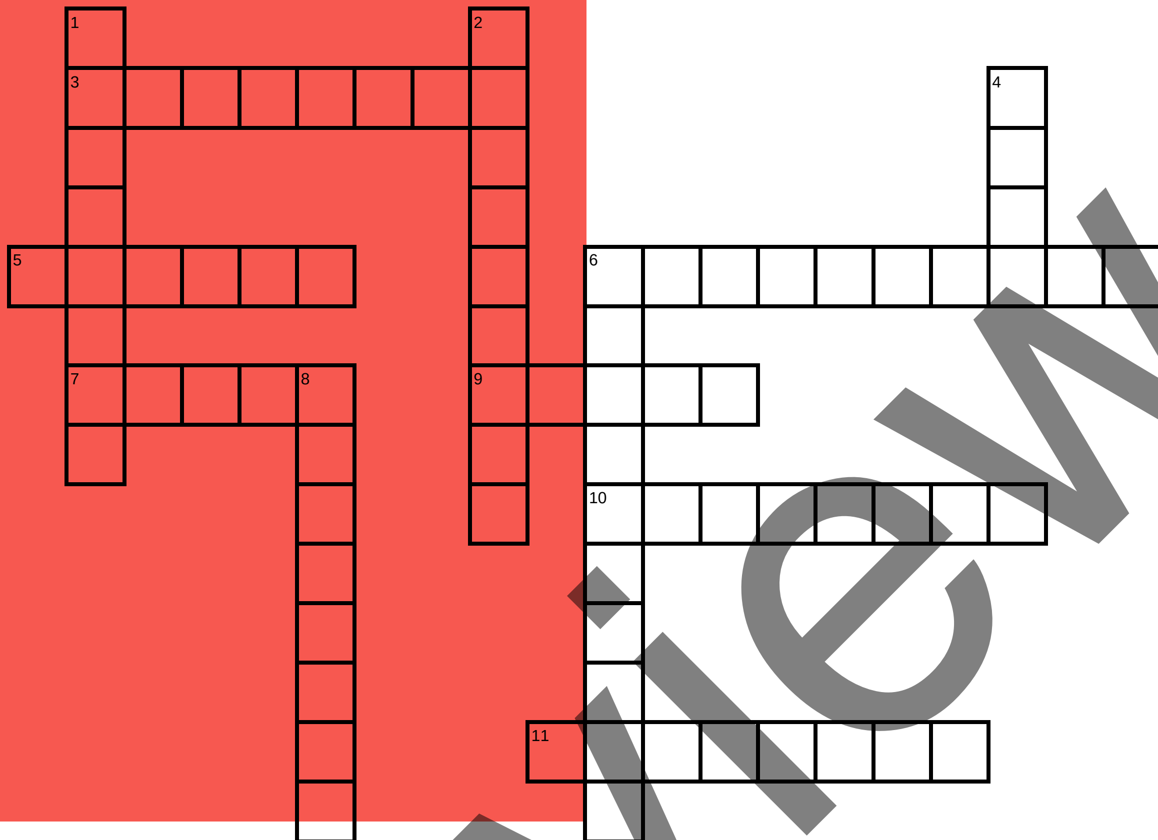
1. Find the expression below that does not belong because it is not equivalent to the other three. Then choose at least one more and explain why it doesn't belong.

A $\frac{4(3x + 2)}{8}$	**B** $\frac{12x + 2}{8}$
C $\frac{3x}{2} + 1$	**D** $\frac{4 \bullet 3x}{8} + \frac{4 \bullet 2}{8}$

2. Find the expression below that does not belong because it is not equivalent to the other three. Then choose at least one more and explain why it doesn't belong.

A $\frac{-2(1.5n - 3)}{\frac{1}{2}}$	**B** $\frac{-3n - 6}{\frac{1}{2}}$
C $(-3n + 6)2$	**D** $-6n + 12$

VOCABULARY REVIEW



Across

3 unknown, value not yet specified

5 typically associated with the "dependent variable"

6 expressions that represent the same number for any value of the variable

7 in the expression, 5 – 2x, 5 and 2x are called ____

9 typically associated with "independent variable"

10 statement that asserts two expressions are equal

11 a term with a fixed numerical value

Down

1 to find the value of

2 illustration of additive inverse property with the counter model (2 words)

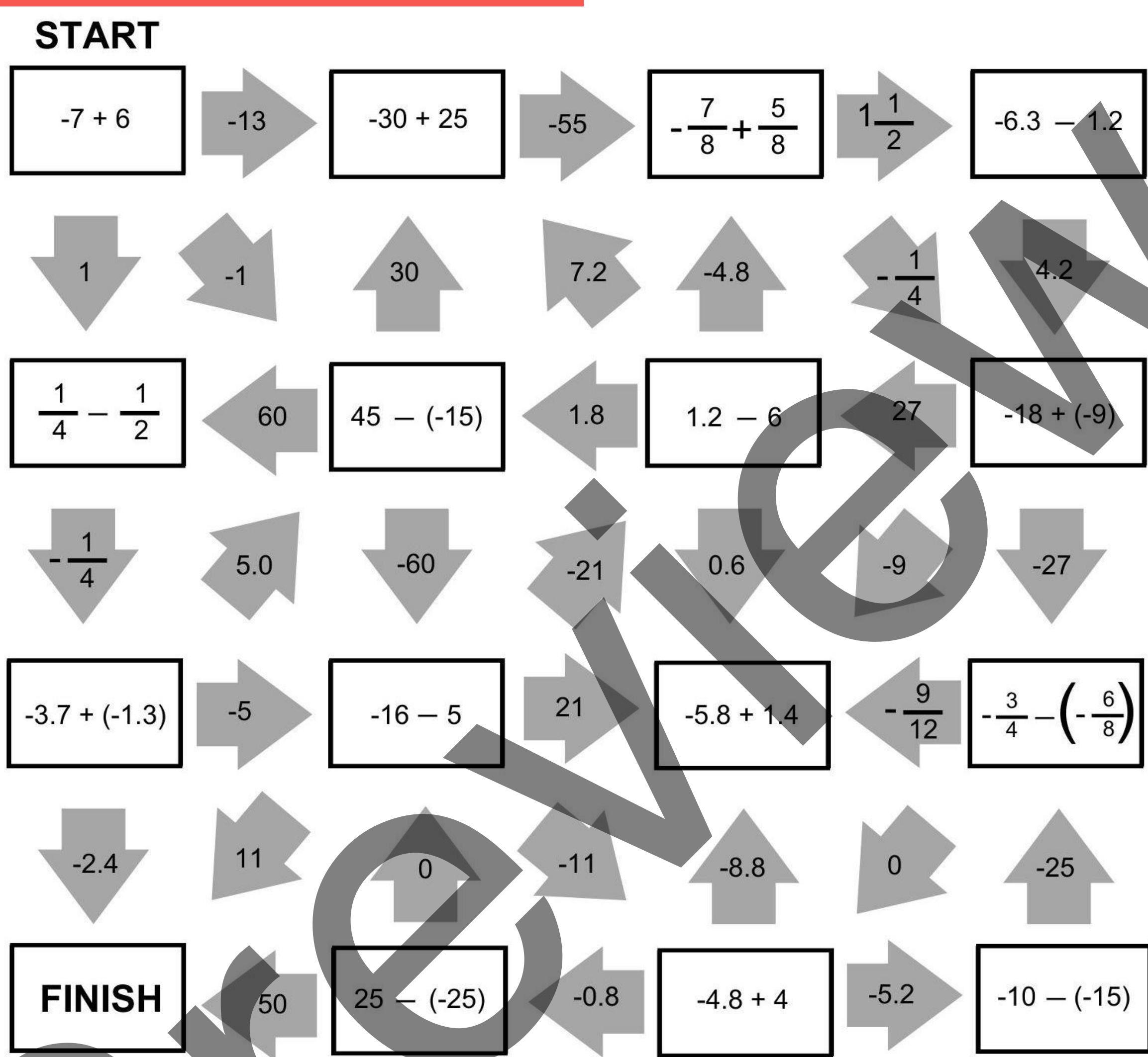
4 terms with the same variable part, such as 5x and -2x

6 a combination of numbers, variables, and operation symbols

8 to write an expression in a more usable form

SPIRAL REVIEW

1. Follow the math path to computational fluency.



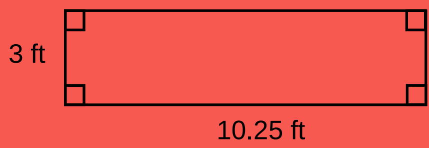
2. Complete the table. Round to the nearest cent.

	10% increase and new total	20% increase and new total	5% increase and new total	15% increase and new total	1% increase and new total
$16.50					
					$0.28 $28.28

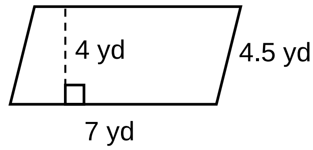
SPIRAL REVIEW
Continued

3. Find the area of each polygon below. Drawings are not to scale.

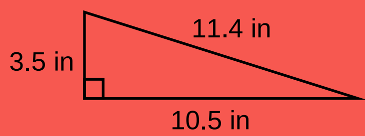
a.



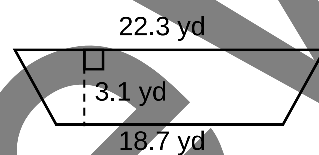
b.



c.

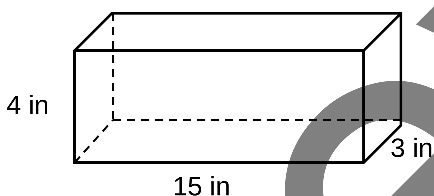


d.

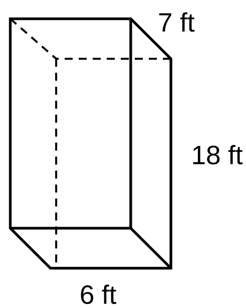


4. Find the volume of each rectangular prism below.

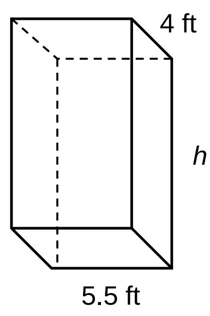
a.



b.



5. Find the height of the prism to the right if the volume is 220 cubic feet.



SPIRAL REVIEW

Continued

6. A bag of marbles contains 3 blue, 4 yellow, 8 green, and 5 red. You are going to pick a marble without looking into the bag. Determine the probability of each event occurring on your first pick. Write each probability as a fraction, decimal, and percent.

a. *P* (a blue marble)	b. *P* (a blue or red marble)
c. *P* (a red marble)	d. *P* (a yellow marble)
e. *P* (a marble that is not blue)	f. *P* (a pink marble)

7. On a map, $\frac{1}{8}$ inch represents one mile. Anderson, Pendleton, and Belton are three cities on the map.

   a. If the actual distance between the towns of Anderson and Belton is 11 miles, how far apart are Anderson and Belton on the map?

   b. If Anderson and Pendleton are $1\frac{7}{8}$ inches apart on the map, what is the actual distance between Anderson and Pendleton in miles?

8. The distance between Tulsa and Oklahoma City is 100 miles. The scale on the map is 1 inch = 40 miles. What is the distance on the map?

REFLECTION

1. **Big Ideas**. Shade all circles that describe big ideas in this packet. Draw lines to show connections that you noticed.

   - Find the likelihood of events with probability. (7.SP.C)
   - Sample to understand populations with statistics. (7.SP.AB)
   - Apply proportional reasoning to ratios, rates, percent and scale. (7.RP.A)
   - Solve problems involving measurements of geometric figures. (7.G.B)
   - Operate with rational numbers and solve problems. (7.NS.A)
   - Develop spatial reasoning in two- and three-dimensions. (7.G.A)
   - Use algebra as a problem-solving tool. (7.EE.AB)

   Give an example from this packet of one of the connections above.

2. **Packet Progress.** Go back to **Monitor Your Progress** on the cover and complete or update your responses. Explain something you understand better now than before.

3. **Mathematical Practices.** Explain a situation when you decontextualized a problem using symbols, manipulated them, and then interpreted your result based on the context. [SMP2]

4. **Making Connections.** What are some ways to represent changing quantities? For the Visual Patterns Problems in Lesson 2, which representation(s) do you think best describe the data?

STUDENT RESOURCES

Word or Phrase	Definition
additive inverse property	The additive inverse property states that $a + (-a) = 0$ for any number a. In other words, the sum of a number and its opposite is 0. The number $-a$ is the additive inverse of a. $3 + (-3) = 0$, $-25 + 25 = 0$
coefficient	A coefficient 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.
constant term	A constant term in an algebraic expression is a term that has a fixed numerical value. In the expression $5 + 2x + 3$, the terms 5 and 3 are constant terms. If this expression is rewritten as $2x + 8$, the term 8 is the constant term of the new expression.
distributive property	The distributive property states that $a(b + c) = ab + ac$ and $(b + c)a = ba + ca$ for any three numbers a, b, and c. $3(4 + 5) = 3(4) + 3(5)$; $(4 + 5)8 = 4(8) + 5(8)$; $6(8 – 1) = 6(8) – 6(1)$
equation	An equation is a mathematical statement that asserts the equality of two expressions. $18 = 8 + 10$ is an equation that involves only numbers. This is a numerical equation. $18 = x + 10$ is an equation that involves numbers and a variable and $y = x + 10$ is an equation that involves a number and two variables. These are both algebraic (variable) equations.
equivalent expressions	Two mathematical expressions are equivalent if, for any possible substitution of values for the variables, the two resulting numbers are equal. In particular, two numerical expressions are equivalent if they represent the same number. See expression. The numerical expressions $3 + 2$ and $6 – 1$ are equivalent. Both are equal to 5. The algebraic expressions $3(x + 2)$ and $3x + 6$ are equivalent. For any value of the variable x, the expressions represent the same number.
evaluate	Evaluate refers to finding a numerical value. To evaluate an expression, replace each variable in the expression with a value and then calculate the value of the expression. To evaluate the numerical expression $3 + 4(5)$, we calculate $3 + 4(5) = 3 + 20 = 23$. To evaluate the variable expression $2x + 5$ when $x = 10$, we calculate $2x + 5 = 2(10) + 5 = 20 + 5 = 25$.
expression	A mathematical expression 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 19, $7x$, $a + b$, $\frac{8 + x}{10}$, and $4v – w$.

<table>
<tr><th>Word or Phrase</th><th>Definition</th></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><td>input value (x)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>x</td></tr>
<tr><td>output value (y)</td><td>1.5</td><td>3</td><td>4.5</td><td>6</td><td>7.5</td><td>$1.5x$</td></tr>
</table>

In the table above, the input-output rule could be $y = 1.5x$. In other words, to get the output value, multiply the input value by 1.5. If $x = 100$, then $y = 1.5(100) = 150$.

The “independent variable” is typically associated with the input value, and the “dependent variable” is typically associated with the output value.</td></tr>
<tr><td>like terms</td><td>See <u>terms</u>.</td></tr>
<tr><td>proportional</td><td>Two variables are <u>proportional</u> if the values of one are the same constant multiple of the corresponding values of the other. The variables are said to be in a <u>proportional relationship</u>, and the constant is referred to as the <u>constant of proportionality</u>.

If Wrigley eats 3 cups of kibble each day, then the number of cups of kibble is proportional to the number of days. If x is the number of days, and y is the number of cups of kibble, then $y = 3x$. The constant of proportionality is 3.</td></tr>
<tr><td>proportional relationship</td><td>See <u>proportional</u>.</td></tr>
<tr><td>simplify</td><td><u>Simplify</u> refers to converting a numerical or variable expression to a simpler form. A variable expression might be simplified by combining like terms. A fraction might be simplified by dividing numerator and denominator by a common divisor.

$2x + 6 + 5x + 3 = 7x + 9$ $\qquad \frac{8}{12} = \frac{2}{3}$</td></tr>
<tr><td>terms</td><td>The <u>terms</u> in a mathematical expression involving addition (or subtraction) are the quantities being added (or subtracted). Terms with the same variable part are called <u>like terms</u>.

The expression $2x + 6 + 3x + 5$ has four terms: $2x$, 6, $3x$, and 5. The terms $2x$ and $3x$ are <u>like terms</u>, since each is a constant multiple of x. The terms 6 and 5 are <u>like terms</u>, since each is a constant.</td></tr>
<tr><td>variable</td><td>A <u>variable</u> is a quantity whose value has not been specified. Variables are used in many different ways. They may refer to quantities that vary in a relationship (as in a formula or an input-output rule). They may refer to unknown quantities in expressions, equations or inequalities. Finally, they may be used to generalize rules of arithmetic.

In the equation $d = rt$, the quantities d, r, and t are variables.

In the equation $2x = 10$, the variable x may be referred to as the unknown.

The equation $a + b = b + a$ generalizes the commutative property of addition for all numbers a and b.</td></tr>
</table>

The Coordinate Plane: Quadrant I

In this packet, all graphing is done in Quadrant I, because all coordinates graphed are nonnegative. A coordinate plane is determined by a horizontal number line (the *x*-axis) and a vertical number line (the *y*-axis) intersecting at the zero on each line. The point of intersection (0, 0) of the two lines is called the origin. Points are located using ordered pairs (*x*, *y*).

- The first number (*x*-coordinate) indicates how far the point is to the right of the *y*-axis.
- The second number (*y*-coordinate) indicates how far the point is above the *x*-axis.

Point, coordinates, and interpretation

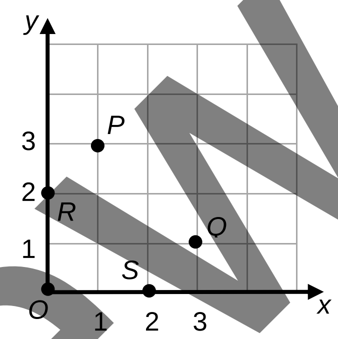
O (0, 0) ⟶ at the intersection of the axes

P (1, 3) ⟶ start at the origin, move 1 unit right, then 3 units up

Q (3, 1) ⟶ start at the origin, move 3 units right, then 1 unit up

R (0, 2) ⟶ start at the origin, move 0 units right, then 2 units up

S (2, 0) ⟶ start at the origin, move 2 units right, then 0 units up



Multiple Representations: Tables, Graphs, and Equations

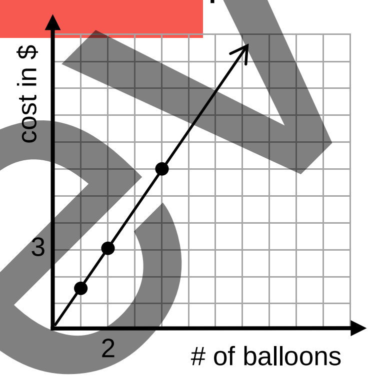
Suppose 4 balloons cost $6.00 and each balloon is the same price. Here are some representations for this relationship.

Table

Number of Balloons	Cost in $
4	6.00
2	3.00
1	1.50
8	12.00

Note that the unit price is $1.50 per balloon.

Graph



Numbers of balloons must be discrete values (specifically, whole numbers). A trend line may be drawn to show a growth pattern.

Equation (input-output rule)

Let *y* = cost in dollars
Let *x* = number of balloons.

We can see from the table that the unit price is 1.50 dollars per balloon.

It appears that multiplying any input value by 1.5 yields its corresponding output value.

Therefore, $y = 1.5x$.

Variables in Algebra	
Loosely speaking, variables are quantities that can vary. Variables are represented by letters or symbols. Variables have many different uses in mathematics. The use of variables, together with the rules of arithmetic, makes algebra a powerful tool. Three important ways that variables appear in algebra:	
Usage	**Examples**
Variables can represent an *unknown quantity* in an equation or inequality. In this case, the equation is valid only for specific value(s) of the variable.	$x + 4 = 9$ $5n = 20$ $y < 6$
Variables can represent *quantities that vary* in a relationship. In this case, there is always more than one variable in the equation.	Formula: $P = 2\ell + 2w$, $A = s^2$ Function (input-output rule): $y = 5x$, $y = x + 3$
Variables can represent *quantities in statements that generalize* rules of arithmetic. In this case, there may be one or more variables.	Commutative property of addition: $x + y = y + x$ Distributive property: $x(y + z) = xy + xz$

Evaluate or Simplify?

We use the word "evaluate" when we want to calculate the value of an expression.

To evaluate 16 – 4(2), follow the rules for order of operations and compute.

$$16 - 4(2) = 16 - 8 = 8$$

To evaluate $6 + 3x$ when $x = 2$, substitute 2 for x and calculate.

$$6 + 3(2) = 6 + 6 = 12$$

We use the word "simplify" when rewriting a number or an expression in a form more easily readable or understandable.

To simplify $2x + 3 + 5x$, combine like terms: $2x + 3 + 5x = 7x + 3$.

Sometimes it may not be clear what is the simplest form of an expression. For instance, by the distributive property, $4(x + 2) = 4x + 8$. For some applications, $4(x + 2)$ may be considered simpler than $4x + 8$, but for other applications, $4x + 8$ may be considered simpler than $4(x + 2)$.

Equivalent Expressions

Two numerical expressions are <u>equivalent</u> if they are equal.

$2 + 4$ and $-2 + 8$ are equivalent numerical expressions. They are both equal to 6.

Two mathematical expressions are <u>equivalent</u> if, for any possible substitution of values for the variables, the two resulting values are equal.

The expressions $x + 2x$ and $4x - x$ are equivalent. For any value of the variable x, the expressions represent the same number. We see this by combining like terms.

$$x + 2x = 3x \text{ and } 4x - x = 3x$$

The expressions x^2 and $2x$ are NOT equivalent. While they happen to be equal if $x = 0$ or $x = 2$, they are not equal for all possible values of x. For instance, if $x = 1$, then $x^2 = 1$ and $2x = 2$.

Properties of arithmetic, such as the distributive property, can be used to write expressions in different, equivalent ways.

$$4x + 6x = (4 + 6)x \qquad 24x + 9x = 3(8x + 3x) = 3x(8 + 3)$$

Simplifying Expressions Using a Model

In mathematics, we <u>simplify</u> a numerical or algebraic expression by rewriting it in a less complicated form.

We can illustrate simplifying expressions using a cups and counters model.

Positive Counter	Negative Counter	Cup	Upside-down Cup
draw as: **+** value: +1	draw as: **–** value: -1	draw as: **V** value: unknown (x)	draw as: **Λ** value: unknown ($-x$)

Expressions	Pictures	Descriptions
$2(x + 3)$ $= 2x + 6$	**V + + +** **V + + +**	Build the expression. Think: 2 groups of $x + 3$, which is an application of the distributive property.
$-2(x + 3)$ $= -2x - 6$	**Λ – – –** **Λ – – –**	Build the expression. Think: 2 groups of $x + 3$ from above -> then build the opposite (distributive property).
$-2(x - 3)$ $= -2x + 6$	**Λ + + +** **Λ + + +**	Build the expression. Think: 2 groups of $x - 3$ -> then build the opposite (distributive property).
$4x - 2(x - 3)$ $= 4x - 2x + 6$ $= 2x + 6$	**V V Λ + + +** **V V Λ + + +**	Build the expression. Think: 4x AND 2 groups of $x - 3$ -> then build the opposite of the groups (distributive property). Then combine like terms (think zero pairs).

COMMON CORE STATE STANDARDS

STANDARDS FOR MATHEMATICAL CONTENT	
7.RP.A	**Analyze proportional relationships and use them to solve real-world and mathematical problems.**
7.RP.2	Recognize and represent proportional relationships between quantities:
a.	Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
7.RP.3	Use proportional relationships to solve multistep ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.*
7.NS.A	**Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.**
7.NS.3	Solve real-world and mathematical problems involving the four operations with rational numbers.
7.EE.A	**Use properties of operations to generate equivalent expressions.**
7.EE 1	Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
7.EE 2	Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. *For example, $a + 0.05a = 1.05a$ means that "increase by 5%" is the same as "multiply by 1.05."*
7.EE.B	**Solve real-life and mathematical problems using numerical and algebraic expressions and equations.**
7.EE.3	Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.*

STANDARDS FOR MATHEMATICAL PRACTICE	
SMP1	Make sense of problems and persevere in solving them.
SMP2	Reason abstractly and quantitatively.
SMP3	Construct viable arguments and critique the reasoning of others.
SMP4	Model with mathematics.
SMP5	Use appropriate tools strategically.
SMP6	Attend to precision.
SMP7	Look for and make use of structure.
SMP8	Look for and express regularity in repeated reasoning.

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