4.1 Start Thinking

Plot $\triangle ABC$ with coordinates $A(-2, 2)$, $B(-4, -2)$, $C(-1, -1)$, and $\triangle A'B'C'$ with coordinates $A'(-2, 0)$, $B'(-4, -4)$, $C'(-1, -3)$ in a coordinate plane. Describe how to get from $\triangle ABC$ to $\triangle A'B'C'$. Compare the ordered pairs for each triangle visually. Explain how to use the ordered pairs for this exercise.

4.1 Warm Up

Translate point *P*. State the coordinates of *P′*.

1. $P(-4, 4)$; 2 units down, 2 units right
2. $P(-3, -2)$; 3 units right, 3 units up
3. $P(2, 2)$; 2 units down, 2 units right
4. $P(-1, 4)$; 3 units left, 1 unit up
5. $P(2, -1)$; 1 unit up, 4 units right
6. $P(6, 0)$; 4 units up, 2 units left

4.1 Cumulative Review Warm Up

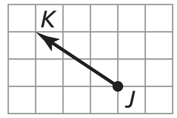
Prove the theorem.

1. Alternate Interior Angles Theorem (Theorem 3.2)
2. Alternate Exterior Angles Theorem (Theorem 3.3)

Name____ Date__________

4.1 Practice A

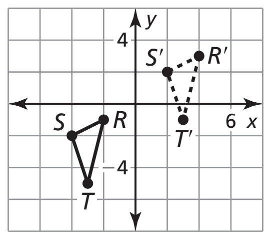
1. Name the vector and write its component form.



2. The vertices of $\triangle ABC$ are $A(2, 3)$, $B(-1, 2)$, and $C(0, 1)$. Translate $\triangle ABC$ using the vector $\langle 1, -4 \rangle$. Graph $\triangle ABC$ and its image.

3. Find the component form of the vector that translates $A(3, -2)$ to $A'(-1, 4)$.

4. Write a rule for the translation of $\triangle RST$ to $\triangle R'S'T'$.



In Exercises 5 and 6, use the translation $(x, y) \rightarrow (x + 1, y - 3)$ to find the image of the given point.

5. $Q(5, 9)$

6. $M(-3, -8)$

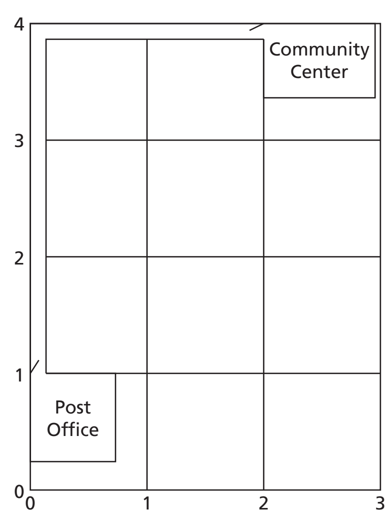
In Exercises 7 and 8, graph $\triangle CDE$ with vertices $C(-1, 3)$, $D(0, -2)$, and $E(1, 1)$ and its image after the given translation or composition.

7. **Translation:** $(x, y) \rightarrow (x - 3, y + 1)$

8. **Translation:** $(x, y) \rightarrow (x + 10, y - 8)$
   Translation: $(x, y) \rightarrow (x - 7, y + 15)$

9. You want to plot the collinear points $A(-2, 3)$, $A'(x, y)$, and $A''(3, 7)$ on the same coordinate plane. Do you have enough information to find the values of x and y? Explain your reasoning.

10. You are using the map shown to navigate through the city. You decide to walk to the Post Office from your current location at the Community Center. Describe the translation that you will follow. If each grid on the map is 0.05 mile, how far will you travel?



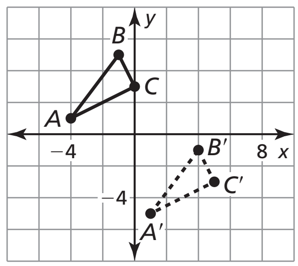
Name ____ Date __________

4.1 Practice B

1. The vertices of $\triangle FGH$ are $F(-2, -6)$, $G(3, 0)$, and $H(1, -4)$. Translate $\triangle FGH$ using the vector $\langle -2, 7 \rangle$. Graph $\triangle FGH$ and its image.

2. Find the component form of the vector that translates $A(-4, 8)$ to $A'(7, -9)$.

3. Write a rule for the translation of $\triangle ABC$ to $\triangle A'B'C'$.



In Exercises 4 and 5, use the translation $(x, y) \to (x - 4, y + 3)$ to find the image of the given point.

4. $G(-2, 4)$

5. $H(-10, 5)$

6. Graph $\triangle JKL$ with vertices $J(-2, 8)$, $K(1, -3)$, and $L(5, 4)$ and its image after the composition.

Translation: $(x, y) \to (x + 6, y - 1)$
Translation: $(x, y) \to (x - 1, y - 7)$

7. Is the transformation given by $(x, y) \to (2x + 2, y + 1)$ a translation? Explain your reasoning.

8. A popular kid's game has 15 tiles and 1 open space. The goal of the game is to rearrange the tiles to put them in order (from least to greatest, starting at the upper left-hand corner and going across each row). Use the figure to write the transformation(s) that describe the path of where the 8 tile is currently, and where it must be by the end of the game. Can this same translation be used to describe the path of all the tiles?

8	2	3	7
5	6	4	14
1	9		13
11	15	10	12

9. Graph any triangle and translate it in any direction. Draw translation vectors for each vertex of the triangle. Is there a geometric relationship between all the translation vectors? Explain why this makes sense in terms of the slope of the line.

10. Point $P(4, -2)$ undergoes a translation given by $(x, y) \to (x + 3, x - a)$, followed by another translation $(x, y) \to (x - b, x + 7)$ to produce the image of $P''(-5, 8)$. Find the values of a and b and point P'.

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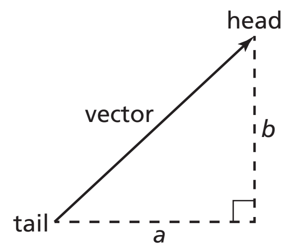
4.1 Enrichment and Extension

Properties of Vectors

A two-dimensional vector $\vec{V} = \langle a, b \rangle$ in standard position with its tail at $(0, 0)$ has a horizontal component a and a vertical component b. The *magnitude* is the length of the line segment, given by $|\vec{V}| = \sqrt{a^2 + b^2}$.
Note: a and b may also be denoted by V_1 and V_2.



1. Find the magnitude of each vector.

a. $\langle 5, -3 \rangle$

b. $\langle -3, 0 \rangle$

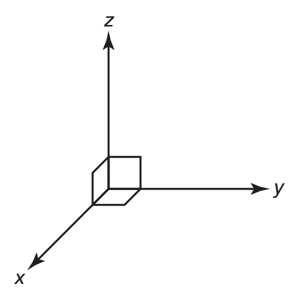
c. head at $(0, 4)$ and tail at $(-3, 2)$

2. Let $\vec{U} = \langle a, b \rangle$ and $\vec{V} = \langle c, d \rangle$ denote vectors in a plane. Write a vector that represents $\vec{U} + \vec{V}$.

3. Let $\vec{U} = \langle 2, -3 \rangle$ and $\vec{V} = \langle -6, 4 \rangle$. Write a vector that represents each of the following.

a. $\vec{U} + \vec{V}$ **b.** $3\vec{U}$ **c.** $\vec{V} - \vec{U}$ **d.** $2\vec{U} + \vec{V}$

You are familiar with coordinates and vectors in the *x*-*y* coordinate plane, but in three dimensions, there are two other coordinate planes. There is the *x*-*z* plane and the *y*-*z* plane. Using the diagram, determine in which plane(s) $(x\text{-}y, x\text{-}z, y\text{-}z)$ each of the following points is located.



4. $(3, 5, 0)$ **5.** $(2, 0, 5)$

6. $(0, -3, 4)$ **7.** $(0, 3, 0)$

So, the magnitude of a vector $\vec{V} = \langle V_1, V_2, V_3 \rangle$ in three dimensions is given by $|\vec{V}| = \sqrt{V_1^2 + V_2^2 + V_3^2}$.

8. Let $\vec{U} = \langle 1, 4, 0 \rangle$ and $\vec{V} = \langle 5, 2, -3 \rangle$. Find the following.

a. $|\vec{U}|$ **b.** $|\vec{V}|$

Name ____ Date __________

4.1 Puzzle Time

What Can Go Up The Chimney Down, But Not Down The Chimney Up?

Write the letter of each answer in the box containing the exercise number.

Complete the following questions.

1. What is another name for the original figure?
2. A translation is a __________ ?
3. A __________ is a quantity that has both direction and magnitude, or size.

Find the coordinates of the preimage.

4. $(x, y) \rightarrow (x + 3, y - 5)$ with endpoints $A'(3, 3)$ and $B'(-2, 4)$
5. $(x, y) \rightarrow (x - 1, y + 3)$ with endpoints $A'(-2, 0)$ and $B'(5, -4)$

Find the rule for the translation of the coordinates.

6. $A(3, -4) \rightarrow A'(1, -8)$
   $B(4, 6) \rightarrow B'(2, 2)$
7. $A(-6, -4) \rightarrow A'(-2, -2)$
   $B(2, 5) \rightarrow B'(6, 7)$

The vector $\langle -3, 2 \rangle$ describes the translations $A(-1, x) \rightarrow A'(-4y, 1)$ and $B(2z - 1, 1) \rightarrow B'(3, 3)$.

8. Find the value of x.
9. Find the value of y.
10. Find the value of z.

2	7		3	6	4	1	5	8	9	10

Answers

A. $\frac{7}{2}$

I. $(x, y) \rightarrow (x + 2, y - 4)$

Y. $A(-3, -6), B(4, -1)$

U. vector

L. $A(6, -2), B(-1, -1)$

N. $(x, y) \rightarrow (x + 4, y + 2)$

V. 1

E. $A(-1, -3), B(6, -7)$

F. 0

B. $A(0, 8), B(-5, 9)$

T. image

M. $(x, y) \rightarrow (x - 2, y - 4)$

G. 2

L. -1

K. flexible motion

R. preimage

L. 1

O. line

A. rigid motion

P. $(x, y) \rightarrow (x - 4, y - 2)$