LESSON 4.2

Apply Translations

Encourage your students to learn more about this occupation and many more in the Pathway2Careers Career Library.

CAREER SPOTLIGHT: Biological Technician

Biological technicians assist biological and medical scientists in laboratories. While this work requires strong knowledge of biology, it also requires knowledge of arithmetic, algebra, geometry, calculus, statistics, computers, and electronics. In addition to setting up equipment and monitoring procedures, biological technicians record, analyze, and interpret data.

- Discuss biological technology with students by reading the Career Spotlight together.
- Find local colleges and universities with biological sciences programs or biological laboratories to share with students.
- Research local companies that employ biological technicians, and ask what they do for the companies.

Video: Biological Technicians

Have students watch this video, which describes the types of projects biological technicians might work on.

Lesson Objective

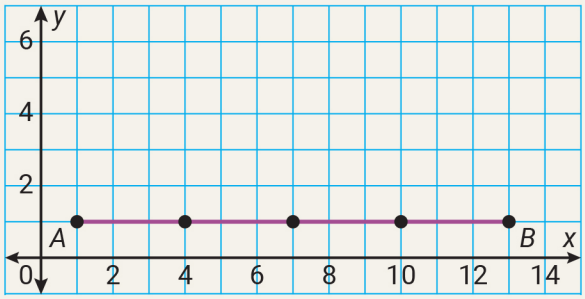
In this lesson, you will look at how a biological technician could apply geometric translations on a coordinate plane to his or her work.

Photo credit: Anyaivanova/Shutterstock.com

Teaching Support

1 Step Into the Career: Translation Functions

Maria is a biological techncian. She is programming a machine to release some liquid from a pipette into test tubes arranged in a rectangular array. The machine follows the path $\overline{AB}$, as shown on the coordinate plane, while dropping liquid into the first row of test tubes. It travels to the remaining test tubes by following the path $T_{\langle 0,\, d\rangle}(\overline{AB})$ for $d = 2$, 4, and 6. Show the path of the pipette when $d = 2$.



Guiding Questions

- In Step 1, in what order are the coordinates presented?
- In Step 3, what are the coordinates of (1, 1) after translating the point up 2 units?

LANGUAGE SUPPORT A *pipette*, from the French for "little pipe," is often used by biologists and chemists to collect and deposit small amounts of liquid.

On the Job: Apply Translation Functions

Answer

1. Path D

Use these questions to check students' understanding.

- How did you determine the coordinate(s) affected by the translation?
- By how much do the coordinates change?
- In which direction do the coordinates change?

2 Step Into the Career: Results of Translations

A biological technician is analyzing the effects of a medication on a subject's ability to walk in a straight line. Before taking the medication, the subject is placed in an empty, round, unmarked room. The position of the subject is noted, and the subject is asked to walk 100 steps across the room. The subject is then asked to turn around and return 100 steps across the room. The subject walks across the room a total of 6 times. The data is recorded on a coordinate plane. During the first walk, the subject begins at (20, –35), goes to (10, –4), ends at (–20, 45), and then returns. The second walk is the translation $T(x, y)_{\langle -5, -2 \rangle}$ of the first walk, and the third walk is the translation $T(x, y)_{\langle -5, -2 \rangle}$ of the second walk. What points does the subject walk through during the second and third walks?

Guiding Questions

- In Step 2, which points are translated?
- In Step 3, which points are translated?

EXTENSION Have students determine whether the subject walks in a straight line and explain their reasoning. If so, ask students to write the equation of the straight line.

(Answer: The subject does not walk in a straight line. The slope between (20, −35) and (10, −4) is $-\frac{31}{10}$, and the slope between (10, −4) and (−20, 45) is $-\frac{49}{30}$.)

On the Job: Apply Results of Translations

Answer

2. (9, 17.5), (39, 47.5), and (79, 57.5)

Use these questions to check students' understanding.

- By how much does the *x*-coordinate change?
- In which direction does the *x*-coordinate change?
- By how much does the *y*-coordinate change?
- In which direction does the *y*-coordinate change?

Photo credit: Elnur/Shutterstock.com

Career Spotlight: Practice

Solution Steps for Exercises 3–6

These steps will help guide students in solving these practice exercises.

Exercise 3

Answer

3. The pipette begins at (1, 7) and goes through (4, 7), (7, 7), (10, 7), and ends at (13, 7).

Solution Steps

- Determine the coordinate(s) affected by the translation $T_{\langle 0,\, d\rangle}(\overline{AB})$. ($y$-coordinate)
- Determine the magnitude and direction of the translation. (6 units up)
- Determine the points of the translated path. ((4, 7), (7, 7), (10, 7), (13, 7))
- Draw the path of the pipette, if needed.

Exercise 4

Answer

4. (100, 200), (125, 250), (150, 300), and (175, 350)

Solution Steps

- Determine the value of d for the third row. (100)
- Determine how the coordinates are affected by the translation $T_{\langle 100,\, 50\rangle}$(Path B). ($x$-coordinate increases by 100 units; y-coordinate increases by 50 units.)
- Determine the locations of the third row of buoys. ((100, 200), (125, 250), (150, 300), and (175, 350))
- Draw the buoys on a coordinate plane, if needed.

Exercise 5

Answers

5a. no

5b. yes; The path of the third microorganism is $T_{\langle 10, -14\rangle}$(path of the first microorganism).

Devise a Plan

Possible plan:

Step 1: Determine the change in the *x*- and *y*-coordinates for each point from the path of the first microorganism to the path of the second microorganism.

Step 2: Compare the changes in the *x*-coordinates and the changes in the *y*-coordinates to determine whether the same changes happen between each corresponding pair of points.

Step 3: Determine the change in the *x*- and *y*-coordinates for each point from the path of the first microorganism to the path of the third microorganism.

Step 4: Compare the changes in the *x*-coordinates and the changes in the *y*-coordinates to determine whether the same changes happen between each corresponding pair of points.

Step 5: Determine the change in the *x*- and *y*-coordinates for each point from the path of the second microorganism to the path of the third microorganism.

Step 6: Compare the changes in the *x*-coordinates and the changes in the *y*-coordinates to determine whether the same changes happen between each corresponding pair of points.

Solution Steps

- Determine the change in the *x*- and *y*-coordinates for each point from the path of the first microorganism to the path of the second microorganism. (⟨7, –5⟩, ⟨7, –5⟩, ⟨5, –7⟩)
- Determine whether the same changes happen between each corresponding pair of points. (no)
- Determine the change in the *x*- and *y*-coordinates for each point from the path of the first microorganism to the path of the third microorganism. (⟨10, –14⟩, ⟨10, –14⟩, ⟨10, –14⟩)
- Determine whether the same changes happen between each corresponding pair of points. (yes)
- Determine the change in the *x*- and *y*-coordinates for each point from the path of the second microorganism to the path of the third microorganism. (⟨3, –9⟩, ⟨3, –9⟩, ⟨5, –7⟩)
- Determine whether the same changes happen between each corresponding pair of points. (no)

Exercise 6

Answer

6. (1, 5), (4, 5), (7, 5), (10, 5), and (13, 5)

Solution Steps

- Determine the value of d for the third row. (4)
- Determine the coordinate(s) affected by the translation $T_{\langle 0,\ 4\rangle}$(Path L). (y-coordinate)
- Determine the magnitude and direction of the translation. (4 units up)
- Determine the locations of the third row of test tubes. ((1, 5), (4, 5), (7, 5), (10, 5), and (13, 5))
- Draw the path of the pipette, if needed.

Career Spotlight: Check

Tips for Completing Exercises 7–10

These tips will help students in solving these exercises and similar assessment items.

Exercise 7

Answer

7. C

Tip Encourage students to consider how each coordinate is affected and to check the scale of the coordinate plane before selecting an answer.

Exercise 8

Answer

8. b, c

Tip Remind students that the only transformation in consideration is a translation and that a pattern made of translations should have no overlaps.

Exercise 9

Answer

9. 200 miles

Tip Encourage students to think about what geese flying in formation looks like and to consider how the paths of all the geese are related by a translation.

Exercise 10

Answer

10. a, b, d, e

Tip Advise students that the translation is applied twice to determine the path of the third bacteria.

LESSON 4.2

Apply Translations

CAREER SPOTLIGHT: Biological Technician

Occupation Description

Biological technicians help biological and medical scientists conduct laboratory tests and experiments.

Biological technicians, sometimes called laboratory assistants, typically are responsible for doing scientific tests, experiments, and analyses under supervision. They use laboratory instruments, robotics, and automated equipment to conduct experiments. They use specialized software to collect, analyze, and model experimental data.

Education

Biological technicians typically need a bachelor's degree in biology or a closely related field.

Students take courses in general biology and specialized subfields as well as chemistry, math, and physics.

Potential Employers

The largest employers of biological technicians are as follows:

Research and development in the physical, engineering, and life sciences	29%
Colleges, universities, and professional schools; state, local, and private	29%
Federal government, excluding postal service	11%
Hospitals; state, local, and private	10%
Pharmaceutical and medicine manufacturing	6%

Watch a video about biological technicians: https://cdn.careeronestop.org/OccVids/OccupationVideos/19-4021.00.mp4

Career Cluster
Agriculture, Food & Natural Resources

Career Pathway
Plant Systems

Career Outlook

- Salary Projections:
  Low-End Salary, $29,540
  Median Salary, $45,860
  High-End Salary, $73,350
- Jobs in 2018: 85,000
- Job Projections for 2028: 90,700 (increase of 7%)

Geometry Concepts

- Describe translations in a coordinate plane as functions.
- Apply translations in a coordinate plane.

Is this a good career for me?
Biological technicians:

- Set up, maintain, and clean laboratory instruments and equipment.
- Gather and prepare biological samples for laboratory analysis.
- Conduct biological tests and experiments.
- Analyze experimental data and interpret results.
- Summarize their findings.

Photo credit: Anyaivanova/Shutterstock.com

Lesson Objective

In this lesson, you will look at how a biological technician could apply geometric translations on a coordinate plane to his or her work.

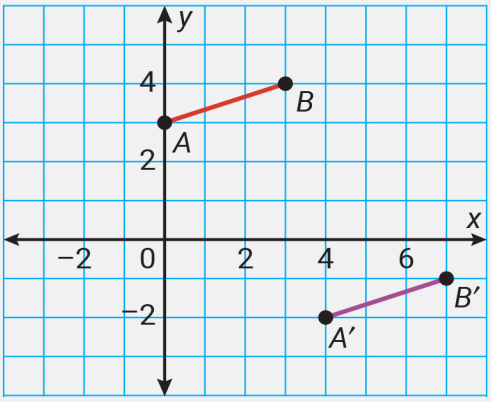
Translations in the Coordinate Plane

A **translation** is a transformation that moves every point in a figure in the same direction and distance.

The function $T_{\langle a,b\rangle}$ translates a point a units horizontally and b units vertically in the coordinate plane where $\langle a, b\rangle$ is the translation vector.

$T_{\langle a,b\rangle}(x, y) = (x + a, y + b)$

The coordinate plane shows $\overline{AB}$ and its translation $T_{\langle 4,-5\rangle}(\overline{AB}) = \overline{A'B'}$.



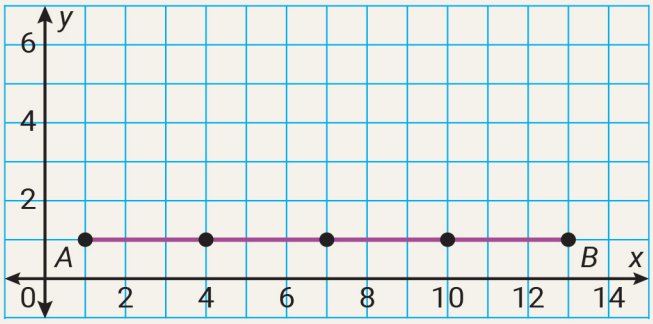
When determining the translation of a line segment on a coordinate plane, you only need to find the translation of the endpoints.

$T_{\langle 4,-5\rangle}(A) = T_{\langle 4,-5\rangle}(0, 3) = (0 + 4, 3 + (-5)) = (4, -2) = A'$

$T_{\langle 4,-5\rangle}(B) = T_{\langle 4,-5\rangle}(3, 4) = (3 + 4, 4 + (-5)) = (7, -1) = B'$

1 Step Into the Career: Translation Functions

Maria is a biological techncian. She is programming a machine to release some liquid from a pipette into test tubes arranged in a rectangular array. The machine follows the path $\overline{AB}$, as shown in the coordinate plane, while dropping liquid into the first row of test tubes. It travels to the remaining test tubes by following the path $T_{\langle 0,\, d\rangle}(\overline{AB})$ for $d = 2$, 4, and 6. Show the path of the pipette when $d = 2$.



Devise a Plan

Step 1: Determine the coordinate(s) affected by the translation $T_{\langle 0,\ 2\rangle}$.

Step 2: Determine the direction of the translation.

Step 3: Draw the path of the pipette.

Walk Through the Solution

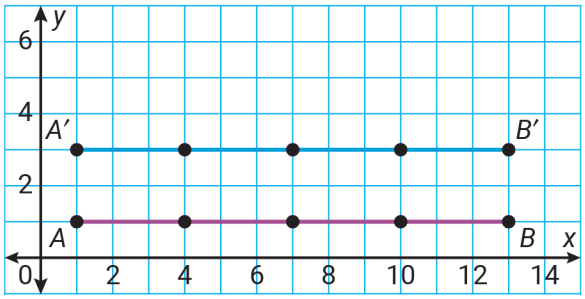
Step 1: Determine the coordinate(s) affected by the translation $T_{\langle 0,\ 2\rangle}$.

Because 0 is in the *x* position of the translation, the *x*-coordinate is not affected. Because 2 is in the *y* position, the *y*-coordinate is affected.

Step 2: Determine the direction of the translation.

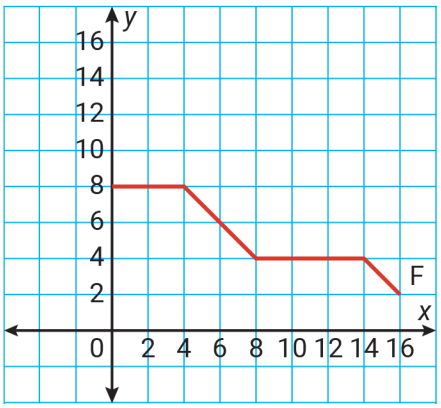
The 2 is positive, so the translation is up 2 units.

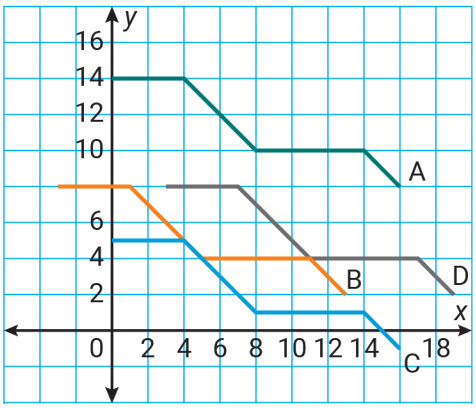
Step 3: Draw the path of the pipette.



On the Job: Apply Translation Functions

1. A biological technician is analyzing tracking data from predator and prey animals. The data is shown on a coordinate plane. During a hunt, the prey animal moved along Path F, and the predator animal followed along the path $T_{\langle 3,\ 0\rangle}$(Path F). Select the path of the predator.





2 Step Into the Career: Results of Translations

A biological technician is analyzing the effects of a medication on a subject's ability to walk in a straight line. Before taking the medication, the subject is placed in an empty, round, unmarked room. The position of the subject is noted, and the subject is asked to walk 100 steps across the room. The subject is then asked to turn around and return 100 steps across the room. The subject walks across the room a total of 6 times. The data is recorded on a coordinate plane. During the first walk, the subject begins at (20, –35), goes to (10, –4), ends at (–20, 45), and then returns. The second walk is the translation $T(x, y)_{\langle -5, -2 \rangle}$ of the first walk, and the third walk is the translation $T(x, y)_{\langle -5, -2 \rangle}$ of the second walk. What points does the subject walk through during the second and third walks?

Devise a Plan

Step 1: Determine how each coordinate is affected by the translation $T_{\langle -5, -2 \rangle}(x, y)$.

Step 2: Determine the points the subject walks through during the second walk.

Step 3: Determine the points the subject walks through during the third walk.

Walk Through the Solution

Step 1: Determine how each coordinate is affected by the translation $T_{\langle -5, -2 \rangle}(x, y)$.

The x-coordinate is decreased by 5 units, and the y-coordinate is decreased by 2 units.

Step 2: Determine the points the subject walks through during the second walk.

The translated points of the second walk are (20 – 5, –35 – 2), (10 – 5, –4 – 2), and (–20 – 5, 45 – 2), or (15, –37), (5, –6), and (–25, 43).

Step 3: Determine the points the subject walks through during the third walk.

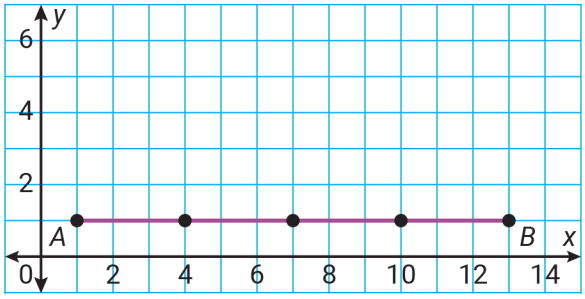
The translated points of the third walk are (15 – 5, –37 – 2), (5 – 5, –6 – 2), and (–25 – 5, 43 – 2), or (10, –39), (0, –8), and (–30, 41).

On the Job: Apply Results of Translations

2. Tracking data from migrating ducks are provided to a biological technician for analysis. The data is plotted on a coordinate plane. The lead duck followed Path G through the points (10, 20), (40, 50), and (80, 60). The last duck in the formation followed $T_{\langle -1, -2.5 \rangle}$(Path G). Through what points did the last duck fly?

Career Spotlight: Practice

3. A biological technician is programming a machine to release some liquid from a pipette into test tubes arranged in a rectangular array. The machine follows the path $\overline{AB}$, as shown in the coordinate plane, while dropping liquid into the first row of test tubes. It travels to the remaining test tubes by following the path $T_{\langle 0,\, d\rangle}(\overline{AB})$ for $d = 2$, 4, and 6. Describe the path of the pipette when $d = 6$.



4. A biological technician is dropping tracking buoys in the ocean. To follow the buoys, the locations are shown on a coordinate plane. The locations of the first row of buoys follow Path B at points (0, 150), (25, 200), (50, 250), and (75, 300). The remaining buoys will be dropped in three more rows at $T_{\langle d,\, 0.5d\rangle}$(Path B) for $d = 50$, 100, and 150. What are the locations of the third row of buoys?

Photo credit: EA Given/Shutterstock.com

5. Julio is a biological technician recording the movements of microorganisms under a microscope to see if there are any patterns. The microorganisms travel in straight lines from one point to another. The movements are recorded on a coordinate plane for comparison. The path of one microorganism starts at (–20, –20), goes to (–10, 17), and ends at (15, 40). The path of a second microorganism starts at (–13, –25), goes to (–3, 12), and ends at (20, 33). The path of a third microorganism starts at (–10, –34), goes to (0, 3), and ends at (25, 26).

a. Is the path of the first microorganism a translation of the path of the second microorganism? If so, what is the translation?

b. Is the path of the third microogranism a translation of the path of either of the other two microorganisms? If so, what is the translation?

Devise a Plan

Step 1: Determine the change in the x- and y-coordinates for each point from the path of the first microorganism to the path of the second microorganism.

Step 2: Compare the changes in the x-coordinates and the changes in the y-coordinates to determine whether the same changes happen between each corresponding pair of points.

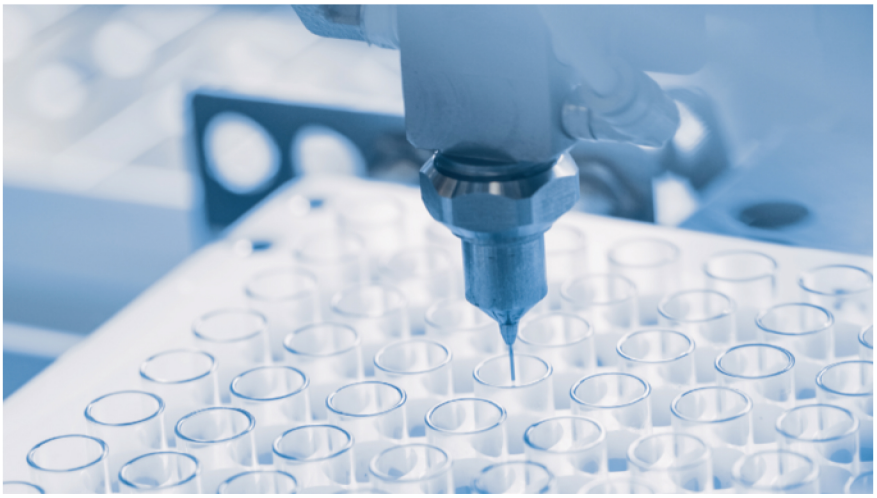
Step 3: _____?_____

Step 4: _____?_____

Step 5: _____?_____

Step 6: _____?_____

6. Dwayne is a biological technician programming a machine to release some liquid from a pipette into test tubes arranged in a rectangular array. The machine follows Path L while dropping liquid into the first row of test tubes. The path is described on a coordinate plane. It travels to the remaining test tubes by following the path $T_{\langle 0,\, d\rangle}$(Path L) for $d = 2$, 4, and 6. If the locations of the first row of test tubes are (1, 1), (4, 1), (7, 1), (10, 1), and (13, 1), what are the locations of the third row?



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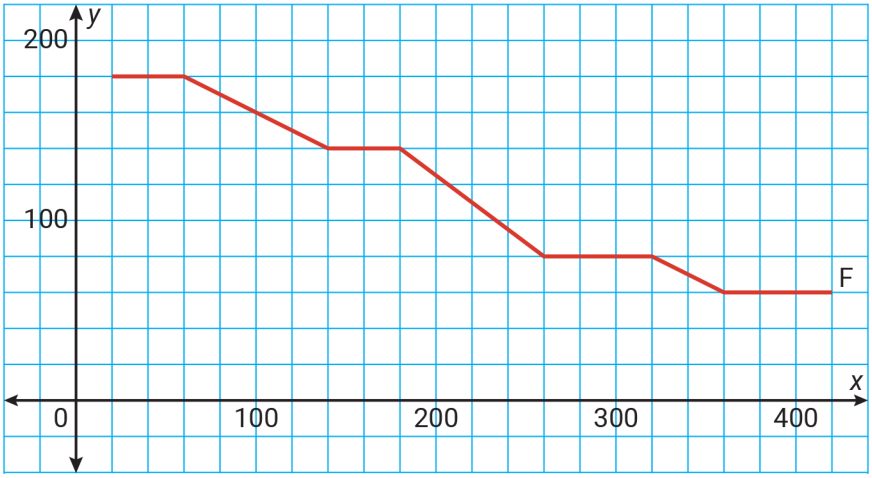
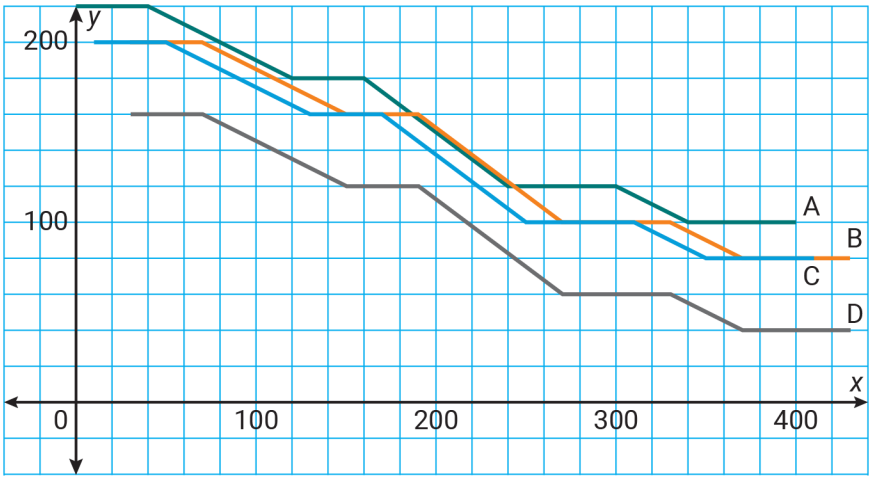
Career Spotlight: Check

7. A biological technician is analyzing tracking data from herds of caribou and packs of wolves as shown in the coordinate plane. During migration, the caribou traveled along Path F.



The wolves followed along the path $T_{\langle -10,\ 20\rangle}$(Path F). Select the path of the wolves.



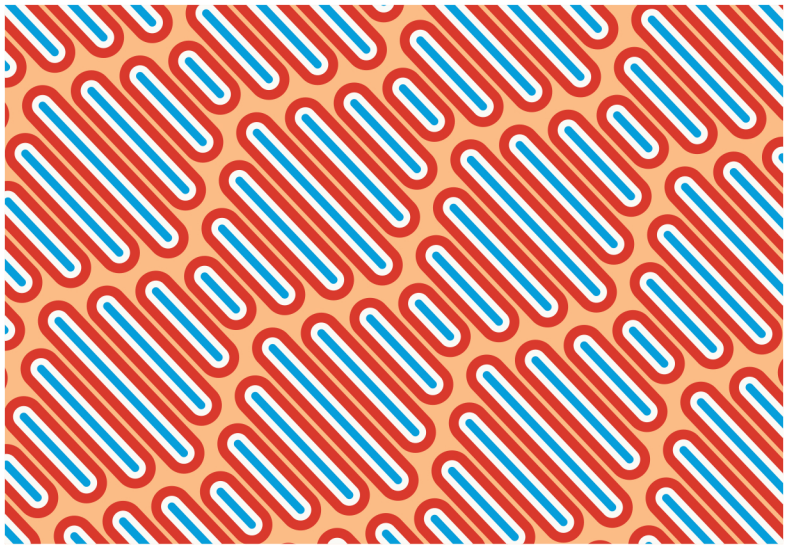
A. Path A

B. Path B

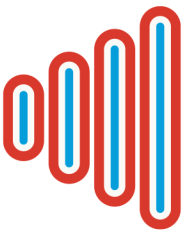
C. Path C

D. Path D

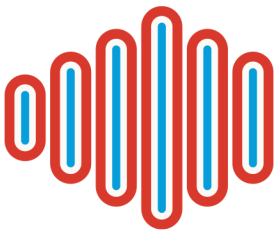
8. A biological technician contributed to the development of sharkskin-inspired antibacterial material. A pattern repeats throughout the material.



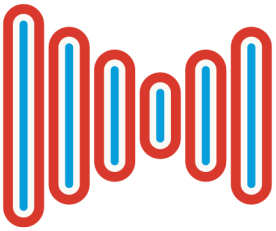
Pattern A



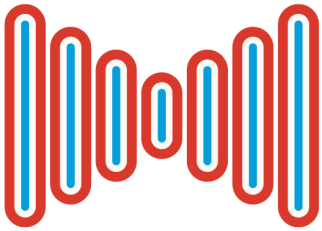
Pattern B



Pattern C



Pattern D



Select all the statements that are true.

a. Multiple translations of Pattern A could replicate the material.

b. Multiple translations of Pattern B could replicate the material.

c. Multiple translations of Pattern C could replicate the material.

d. Multiple translations of Pattern D could replicate the material.

e. No translations of the patterns shown could replicate the material.

9. Shania is a biological technician tracking the path of migrating geese on a coordinate plane. The lead goose followed Path G through the points (10, 20), (40, 50), and (80, 60). The last goose in the formation followed the path $T_{\langle -1, -2.5 \rangle}$(Path G). The lead goose flew a total of 200 miles before landing, and all the geese landed together. How far did the last goose fly?

10. A biological technician is studying how the movements of bacteria follow patterns that can be described by transformations. The movements are recorded on a coordinate plane for observation. One bacteria moves along path that begins at (–25, 43) and ends at (10, –39). The technician observes that the path of a second bacteria can be described by the translation $T_{\langle -5, -2 \rangle}(x, y)$ of the path of the first bacteria and the path of a third bacteria can be descibed by the same translation $T_{\langle -5, -2 \rangle}(x, y)$ of the path of the second bacteria. Determine the starting and ending points of the paths of the other two bacteria.

Select all the statements that are true.

a. The path of one of the other bacteria begins at (–35, 39).

b. The path of one of the other bacteria begins at (–30, 41).

c. The path of one of the other bacteria begins at (–20, 45).

d. The path of one of the other bacteria ends at (0, –43).

e. The path of one of the other bacteria ends at (5, –41).

f. The path of one of the other bacteria ends at (15, –37).

Photo credit: Michael Shake/Shutterstock.com

Notes