Lesson 1: Moving in the plane

Goals

- Describe (orally and in writing) a translation or rotation of a shape using informal language, e.g., “slide,” “turn left,” etc.
- Identify angles and rays that do not belong in a group and justify (orally) why the object does not belong.

Learning Targets

- I can describe how a shape moves and turns to get from one position to another.

Lesson Narrative

The purpose of this lesson is to introduce students to translations and rotations of plane shapes and to have them describe these movements in everyday language. Expect students to use words like “slide” and “turn.” In the next lesson, they will be introduced to the mathematical terms. The term “transformation” is not yet used and will be introduced later in a later lesson.

In all of the lessons in this unit, students should have access to their geometry toolkits, which should contain tracing paper, graph paper, coloured pencils, scissors, ruler, protractor, and an index card. For this unit, access to tracing paper and a straight edge are particularly important. Students may not need all (or even any) of these tools to solve a particular problem. However, to make strategic choices about when to use which tools, students need to have opportunities to make those choices. Apps and simulations should supplement rather than replace physical tools.

Building On

- Recognise angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:

Building Towards

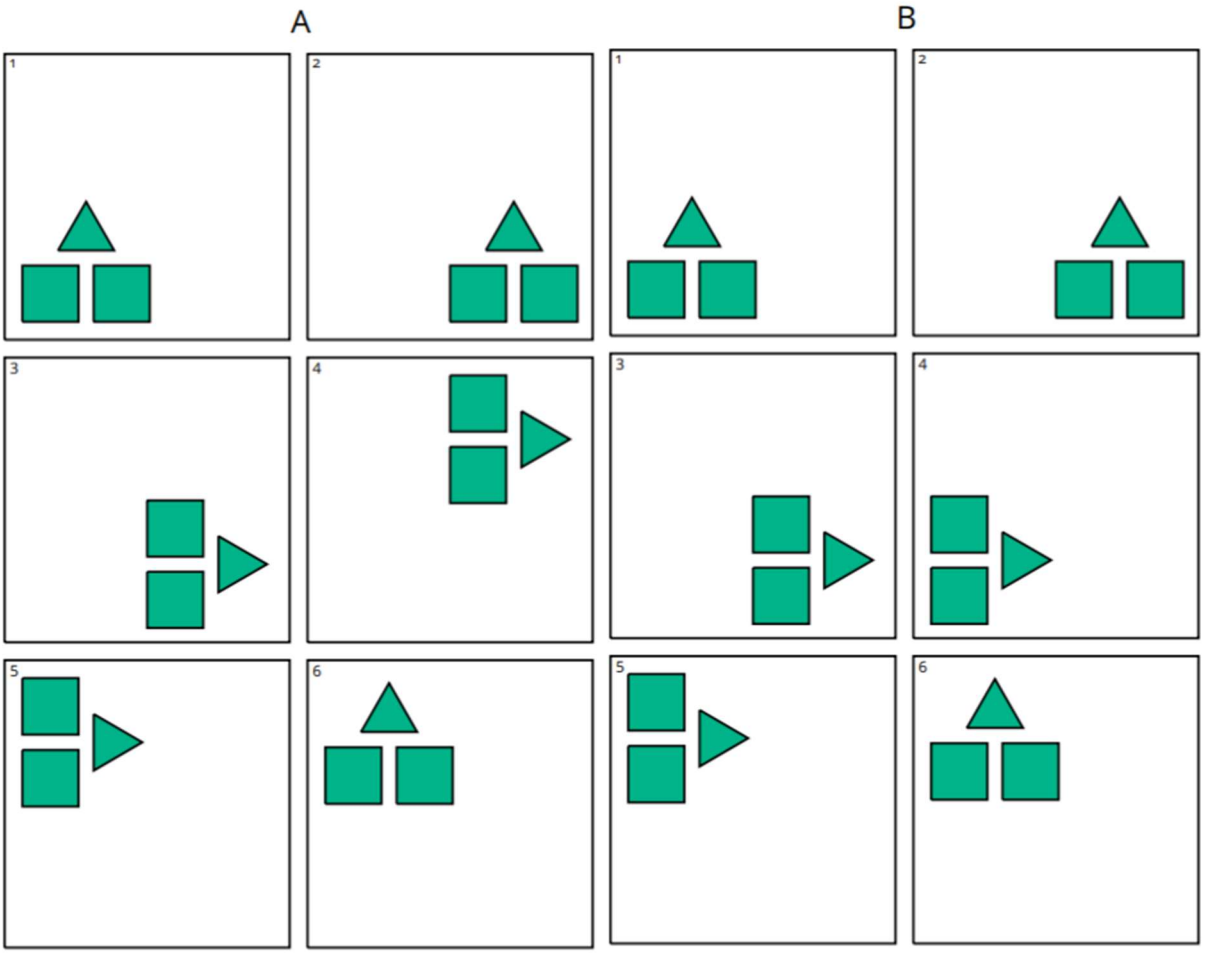
- Verify experimentally the properties of rotations, reflections, and translations:

Instructional Routines

- Discussion Supports
- Think Pair Share
- Which One Doesn’t Belong?

Required Materials

Copies of blackline master
Triangle Square Dance


A
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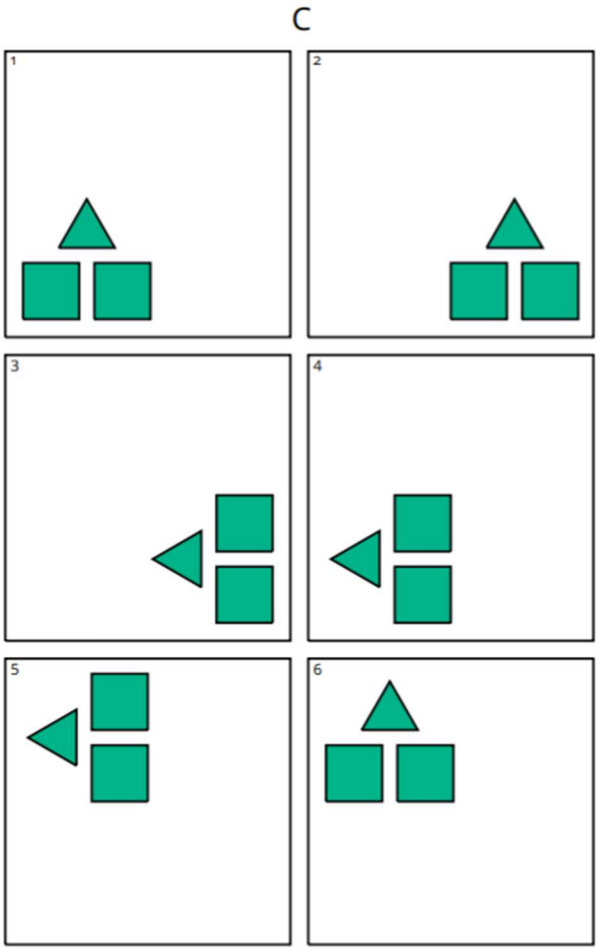


Geometry toolkits
tracing paper, graph paper, coloured pencils, scissors, and an index card to use as a straightedge or to mark right angles, plus a ruler and protractor. Clear protractors with no holes and with radial lines printed on them are recommended.

Required Preparation

You will need the Triangle Square Dance blackline master for this lesson. Make 1 copy of all 3 pages for every 2 students.

Assemble geometry toolkits. It would be best if students had access to these toolkits at all times throughout the unit. Toolkits include tracing paper, graph paper, coloured pencils, scissors, ruler, protractor, and an index card to use as a straightedge or to mark right angles. Access to tracing paper is particularly important in this unit. Tracing paper cut to a small-ish size (roughly 5" by 5") is best.

Student Learning Goals

Let's describe ways shapes can move in the plane.

1.1 Which One Doesn't Belong: Diagrams

Warm Up: 10 minutes

This warm-up prompts students to compare four images. It encourages students to explain their reasoning and hold mathematical conversations. It gives you the opportunity to hear how they use terminology and talk about characteristics of the images in comparison to one another. To allow all students to access the activity, each image has one obvious reason it does not belong. Encourage students to find reasons based on mathematical properties (e.g., Shape B is the only right angle). During the discussion, listen for important ideas and terminology that will be helpful in upcoming work of the unit. The activity also gives students an opportunity to find useful tools in their geometry toolkit.

Before students begin, consider establishing a small, discreet hand signal students can display to indicate they have an answer they can support with reasoning. This signal could be a thumbs up, or students could show the number of fingers that indicate the number of responses they have for the problem. This is a quick way to see if students have had enough time to think about the problem and keeps them from being distracted or rushed by hands being raised around the class.

As students share their responses, listen for important ideas and terminology that will be helpful in upcoming work of the unit, such as reference to angles and their sizes.

Instructional Routines

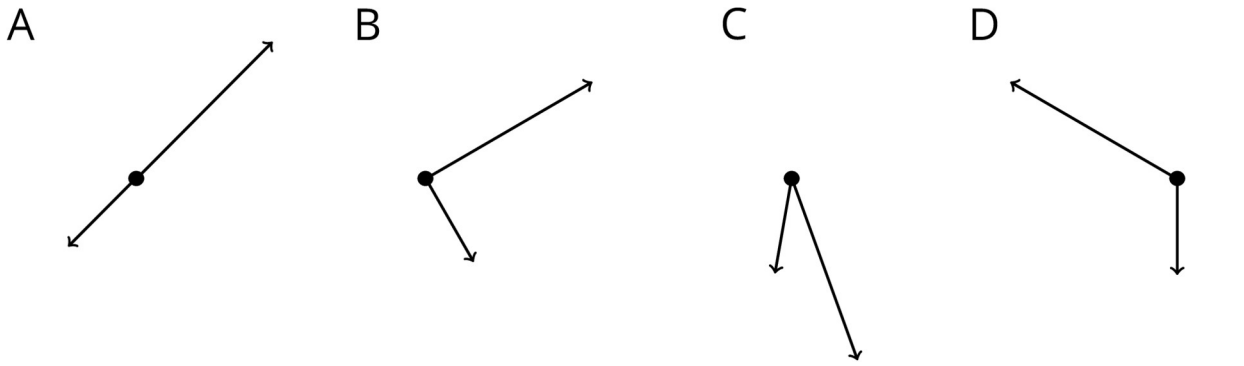
- Think Pair Share
- Which One Doesn't Belong?

Launch

Arrange students in groups of 2–4, and provide access to geometry toolkits. Display the diagrams for all to see. Ask students to indicate when they have noticed one that does not belong and can explain why. Give students 1 minute of quiet think time and then time to share their thinking with their small group. In their small groups, tell each student to share their reasoning why a particular question does not belong. Together, find at least one reason each question doesn't belong.

Student Task Statement

Which one doesn't belong?



Student Response

Answers vary. Sample responses:

A doesn't belong because:

- The rays point in opposite directions.
- It is not possible to make a triangle by joining points on the rays.

B doesn't belong because:

- They make a right angle.
- Both rays are to the right of the vertex.

C doesn't belong because:

- It is an acute angle.
- Both rays point downward.

D doesn't belong because:

- It is an obtuse angle (measuring less than 180 degrees).
- The long ray points to the left of the short ray.

Activity Synthesis

Ask each group to share one reason why a particular image does not belong. Record and display the responses for all to see. After each response, ask the class if they agree or disagree. Since there is no single correct answer to the question of which one does not belong, attend to students' explanations and ensure the reasons given are correct.

During the discussion, prompt students to explain the meaning of any terminology they use, such as ray, degree, or acute angle. Also, press students on unsubstantiated claims. For example, a student may make claims about the angle sizes. Ask how they know the size and demonstrate how the tracing paper or the ruler from the toolkit could be used to check.

1.2 Triangle Square Dance

25 minutes (there is a digital version of this activity)

The purpose of this activity is for students to begin to observe and describe translations and rotations. In groups of 2, they describe one of 3 possible dances, presented in cartoon form, and the partner identifies which dance is being described. Identify students who use specific and detailed language to describe the dance and select them to share during class discussion.

While students are not expected to use precise language yet, this activity both provides the intellectual need for agreeing upon common language and give students a chance to experiment with different ways of describing some moves in the plane.

Instructional Routines

- Discussion Supports

Launch

Arrange students in groups of 2, and give a copy of all 3 blackline masters to each group. Explain that each sheet is a cartoon with 6 frames showing the moves made by the dancing shapes. Instruct students to place all three sheets face up, and tell them to take turns selecting a dance and describing it to their partner, without revealing which dance they have selected. The other student identifies which dance is being described. On a display, record language students use to describe the movement of shapes to later be grouped and connected to more formal language such as "rotation," and "translation." Give students 15 minutes to work in their groups followed by a whole-class discussion.

If using the digital activity, ask students to close their devices. Distribute the blackline masters and review the rules of the game to make sure students understand the task. Give students around 10 minutes to play the game. After 10 minutes, invite students to open their devices and notice how the applets correspond to the three dances. Give students an additional 5 minutes to come to consensus about how to best describe the moves in their own words before a whole-class discussion.

Representation: Provide Access for Perception. Display or provide students with a physical copy of the written directions and read them aloud. Check for understanding by inviting students to rephrase directions in their own words. Consider keeping the display of directions visible throughout the activity.
Supports accessibility for: Language; Memory

Anticipated Misconceptions

Some students may interpret directions like "left" and "right" differently from how their partner intended it, depending on whether they are thinking from the point of view of an observer watching the dance or putting themselves in the dance and describing things in terms of the triangle's left, right, up, and down. Watch for miscommunications like this,

point out that neither perspective is wrong, and encourage students to be more precise in their language.

Students often confuse or are unsure about the meaning of the terms clockwise and anti-clockwise. Discuss with them (and demonstrate, if possible) how the hands on a clock rotate, emphasising the direction of the rotation. Students may also be unsure of how to describe the amount of rotation. Consider asking a student who expresses angle sizes in terms of degrees to explain how they see it.

Student Task Statement

Your teacher will give you three pictures. Each shows a different set of dance moves.

1. Arrange the three pictures so you and your partner can both see them right way up. Choose who will start the game.
   - The starting player mentally chooses A, B, or C and describes the dance to the other player.
   - The other player identifies which dance is being talked about: A, B, or C.
2. After one round, swap roles. When you have described all three dances, come to an agreement on the words you use to describe the moves in each dance.
3. With your partner, write a description of the moves in each dance.

Student Response

Answers vary. Sample response:

A: Move right, turn 90º clockwise, move up, move left, and turn 90º anti-clockwise.

B: Move right, turn 90º clockwise, move left, move up, and turn 90º anti-clockwise.

C: Move right, turn 90º anti-clockwise, move left, move up, and turn 90º clockwise.

The terms left, right, and up in this answer are from the point of view of an observer watching the dance. Alternatively students might put themselves in the shoes of the triangles and describe things in terms of the triangle's left, right, up, and down. Students might use other words, such as "shift" and "step" for translations, and "spin" and "rotate" for the turns. They might describe the 90º turns as "quarter turns."

Are You Ready for More?

We could think of each dance as a new dance by running it in reverse, starting in the 6th frame and working backwards to the first.

1. Pick a dance and describe in words one of these reversed dances.
2. How do the directions for running your dance in the forward direction and the reverse direction compare?

Student Response

1. Answers vary. Sample response:

   A: turn 90º clockwise, move right, move down, turn 90º anti-clockwise, move left,
   B: turn 90º clockwise, move down, move right, turn 90º anti-clockwise, move left,
   C: turn 90º anti-clockwise, move down, move right, turn 90º clockwise, move left

2. The steps are listed in reverse order. Right gets replaced by left and left with right and clockwise gets replaced with anti-clockwise and vice versa.

Activity Synthesis

Select one student to share their description for each of the pages, and display the language you observed and recorded during the activity for the different types of moves. Arrange the words in two groups, those that describe translations and those that describe rotations (but do not use these terms). Come to agreement on a word for each type, and discuss what extra words are needed to specify the transformation exactly (e.g., move right, turn clockwise 90º).

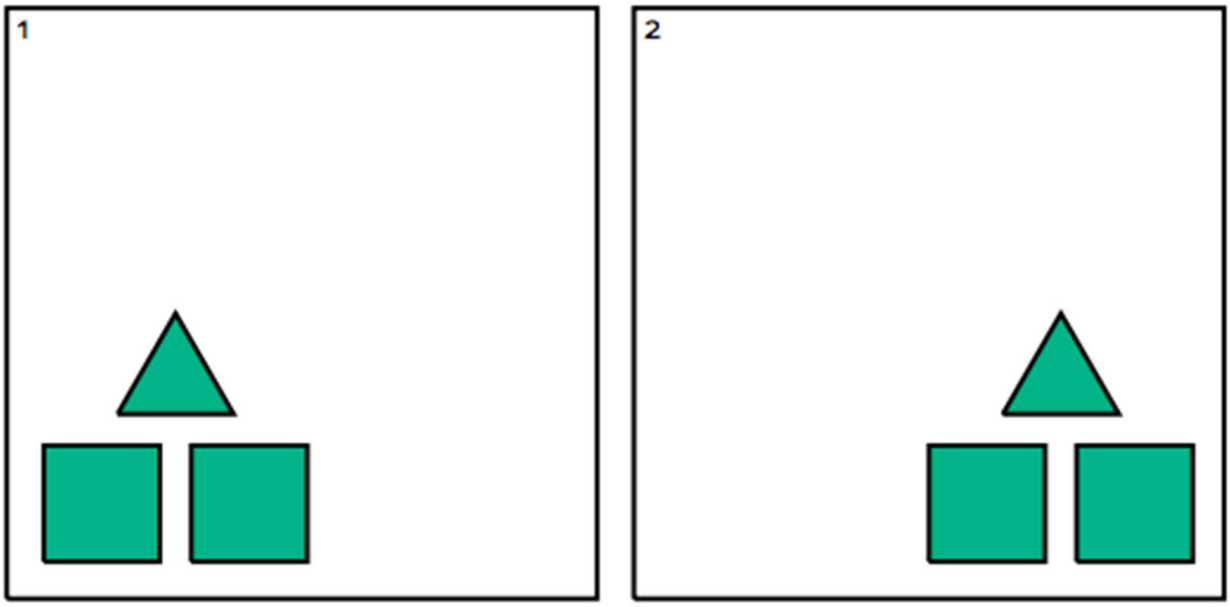
Consider asking students what they found most challenging about describing the dances: expected responses include being as precise as possible about the different motions (for example, describing whether the shape is rotating clockwise or anti-clockwise). Also consider asking students if they were sometimes able to identify the dance before their partner finished describing *all* of the moves. All three dances begin by moving to the right, but in the second step, Dances A and B rotate 90 degrees clockwise while Dance C rotates 90 degrees anti-clockwise. (So if the second move was to rotate 90 degrees anti-clockwise, this must be Dance C.) Dances A and B diverge at slide 4.

Representing: Discussion Supports. To support student understanding of the language on the display, invite students to "act out" each of the different types of moves. Include diagrams or pictures on the display to provide students with a visual reminder of the meaning of each term. For example, draw arrows to help illustrate direction. Remind students to borrow language from the display as needed.
Design Principle(s): Support sense-making

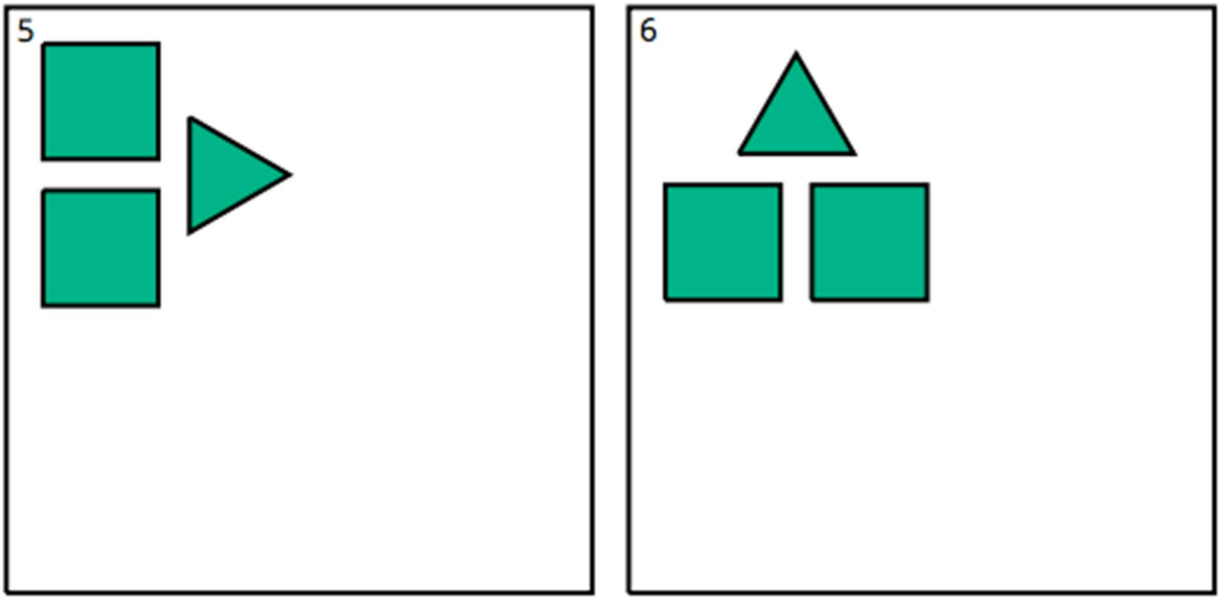
Lesson Synthesis

We have started to reason about what it means to move a shape in the plane. Display two shapes that clearly show a slide and two shapes that clearly show a turn.

Example of a slide:



Example of a turn:



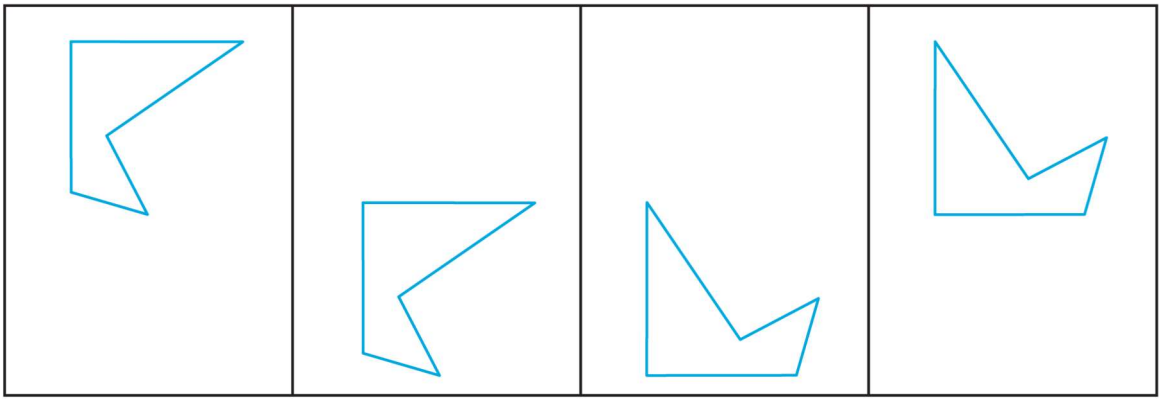
Invite students to share the language they would use to describe them: for example "moving" or "sliding" for translations and "turning" for rotations. Consider asking students how they might *quantify* each move, for example with a distance and direction for the slides and a centre and angle of rotation for the turns. Tell them that we will continue to look at these moves in more detail in future lessons.

1.3 Frame to frame

Cool Down: 5 minutes

Student Task Statement

Here are successive positions of a shape:



Describe how the shape moves from:

1. Frame 1 to frame 2.
2. Frame 2 to frame 3.
3. Frame 3 to frame 4.

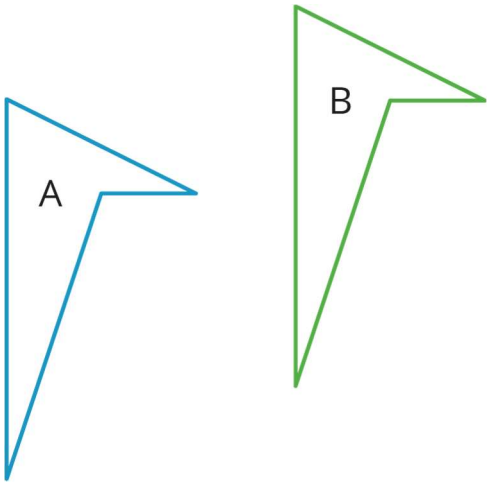
Student Response

1. Slide down.
2. Turn anti-clockwise 90 degrees (or one quarter of a full turn).
3. Slide up.

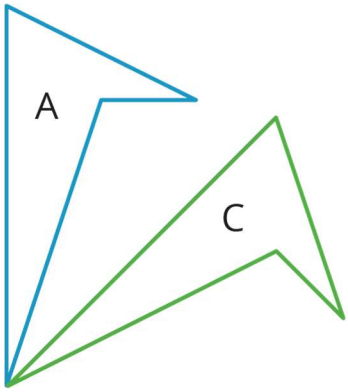
Student Lesson Summary

Here are two ways for changing the position of a shape in a plane without changing its shape or size:

- Sliding or shifting the shape without turning it. Shifting shape A to the right and up puts it in the position of shape B.



- Turning or rotating the shape around a point. Shape A is rotated around the bottom **vertex** to create shape C.



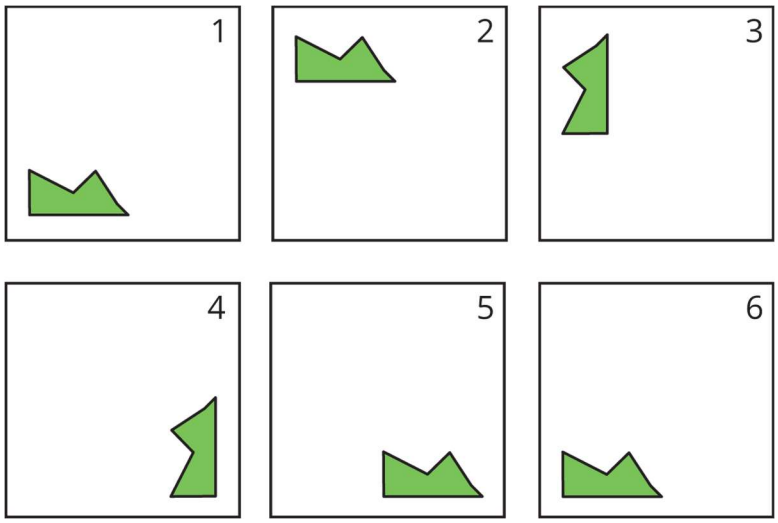
Glossary

- Vertex

Lesson 1 Practice Problems

1. **Problem 1 Statement**

   The six frames show a shape's different positions.



   Describe how the shape moves to get from its position in each frame to the next.

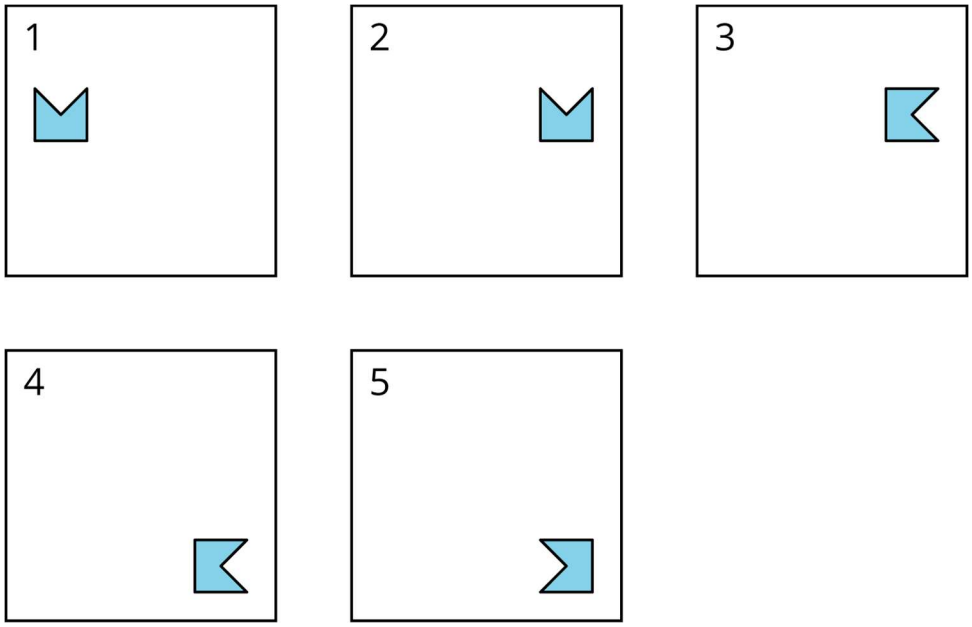
   Solution

   To get from position 1 to position 2, the shape moves up. To get from position 2 to position 3, the shape rotates 90 degrees anti-clockwise. To get from position 3 to position 4, the shape moves down and to the right. To get from position 4 to position 5 the shape rotates 90 degrees clockwise. To get from position 5 to position 6, the shape moves to the left.

   Note: 90 degrees anti-clockwise is the same as 270 degrees clockwise, and similarly 90 degrees clockwise is the same as 270 degrees anti-clockwise.

2. **Problem 2 Statement**

   These five frames show a shape's different positions.



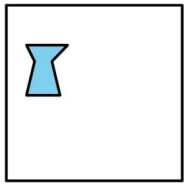
Describe how the shape moves to get from its position in each frame to the next.

Solution

To get from position 1 to position 2, the shape moves to the right. To get from position 2 to position 3, the shape rotates 90 degrees clockwise. To get from position 3 to position 4, the shape moves down. To get from position 4 to position 5, the shape rotates 180 degrees.

3. **Problem 3 Statement**

Diego started with this shape.



Diego moves the shape down, turns it 90 degrees clockwise, then moves the shape to the right. Draw the location of the shape after each move.

Solution