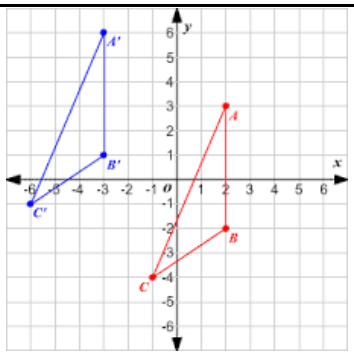
ACE
ARGUMENT-CENTERED EDUCATION



Justify and Critique Activity: Transformations in the Coordinate Plane

Overview

Current standards in mathematics require that students be able to "construct viable arguments and critique the reasoning of others" (Common Core Standards, Standards of Math Practice 3). Further, "mathematically proficient students . . . justify their conclusions, communicate them to others, and respond to the arguments of others." This activity has students justifying and making arguments for their solutions to higher-order thinking math questions, and it has students questioning or critiquing the solutions of their classmates.

This Justify and Critique activity is on the high school mathematics content: transformations in the coordinate plane. The questions used in the activity are taken from the "argument-based mathematics reasoning" question set and activity, produced by Argument-Centered Education. Note that 'critique' doesn't mean exclusively 'contradict.' 'Critique' can mean agree but with a difference, a variation, or a slight difference in explanation. The important thing is that there are competing ideas in play.

Method and Procedure

(1) Start by contextualizing the activity within the foundational academic argumentation components of evidence and refutation. "Justifying a solution" is the near-equivalent of providing evidence and reasoning – using the principles of mathematics – to

articulate why the solution is true. "Critiquing mathematical reasoning" is doing the kind of critical thinking – note the close etymological connection – that refutation activates. Students will critique other students' justifications, and then other students will come back to refute critiques, in this activity. In justifying their solution, students will explain and show evidence of the mathematical reasoning they used to come to their solution. In critiquing mathematical reasoning students will think critically about and evaluate the mathematical reasoning of others.

(2) If this is the first use of an argument-based strategy this year, the teacher should consider showing one of the videos that Argument-Centered Education has collected that demonstrate what argumentation can look like in the math classroom.

(3) Students should be put in pairs. Then each pair should be assigned another pair that they will be matched against for this activity, forming quads.

(4) The two-person pairs of students should work on solving all of the problems below on the math content: transformations in the coordinate plane. While solving the problems they should work in pairs, not in quads.

(5) Each pair should talk through and take notes on their justifications for their solutions, and be ready to present their justification to the class.

(6) The first quad of four students (two pairs) should then be called up to the front of the class to conduct their justification and critique. One pair should be selected by the instructor to go first answering and justifying their answer to the first problem. Then the second pair should be asked to critique the justification presented by the first pair. The critique should address the questions:

Do you agree with the solution?
Was the justification clearly expressed?
Did the justification draw on valid mathematical principles?
Was there anything missing or inaccurate in the justification?
Can you provide a justification that would be fuller or more valid? What makes it so?

The first pair then gets a chance to respond to and (if applicable) refute the critique.

(7) The tables are turned for the next problem. The second pair should solve this problem and justify their solution. The first pair should then critique the second pair's justification. The second pair should (if applicable) try to refute the critique.

(8) Student pairs should be allowed to use a document camera, under the instructor's supervision, in order to demonstrate their work.

(9) Each group of students should go up to the front of the class to participate in the Justify and Critique activity, in turn. Occasionally, the instructor should ask students who are observing questions to check for their understanding and to involve them in the on-going learning project.

(10) A separate rubric can be used to assess student pairs' justification and critique and the mathematical reasoning they conducted and communicated. Or the activity can be conducted without a formal or direct assessment component. Also, the instructor can ask students at the end of the activity to select the pair with the strongest justification of their solution, and the pair with the strongest critique of another pair's justification, awarding bonus points to these pairs.

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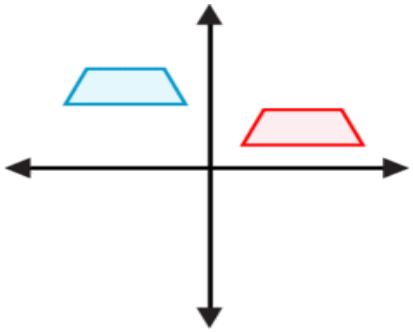
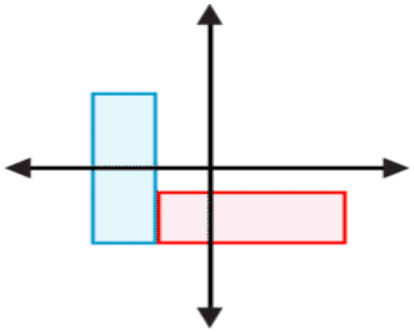
Transformations in the Coordinate Plane Problems

Identify each of the transformations below as a **translation, reflection,** or a **rotation.**



(1.)



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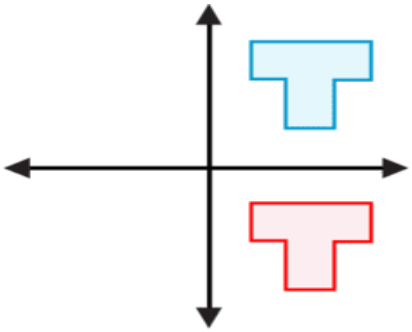

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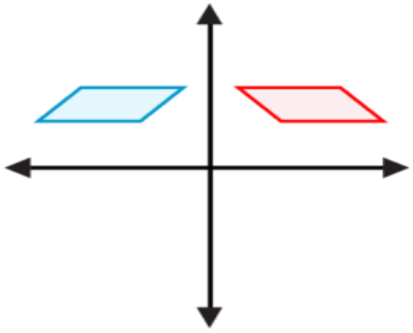
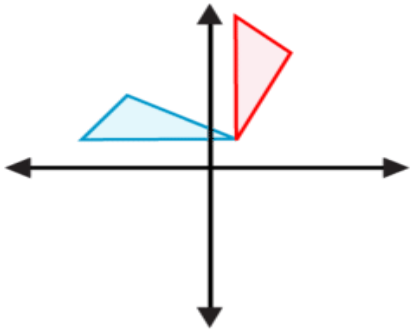
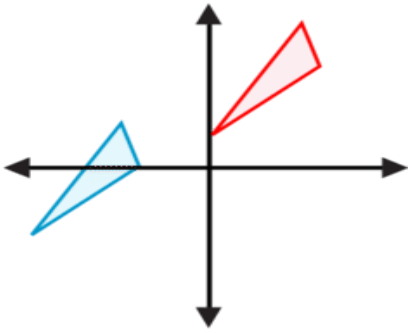


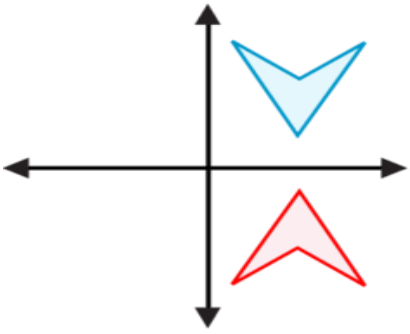
(4.)



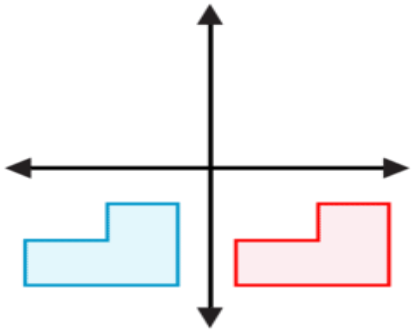
(5.)



(6.)

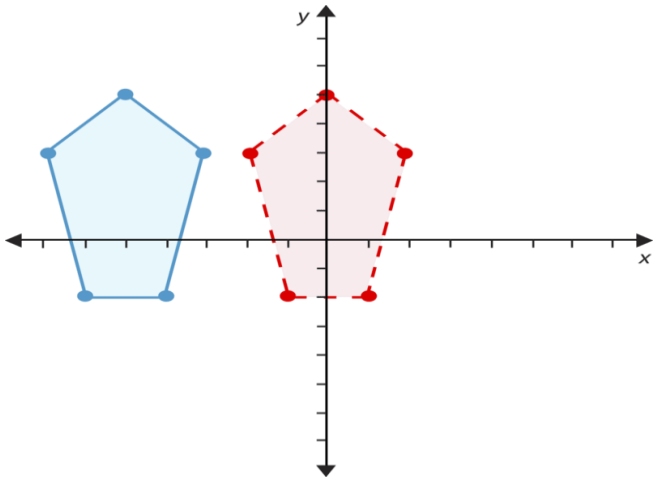


(7.)

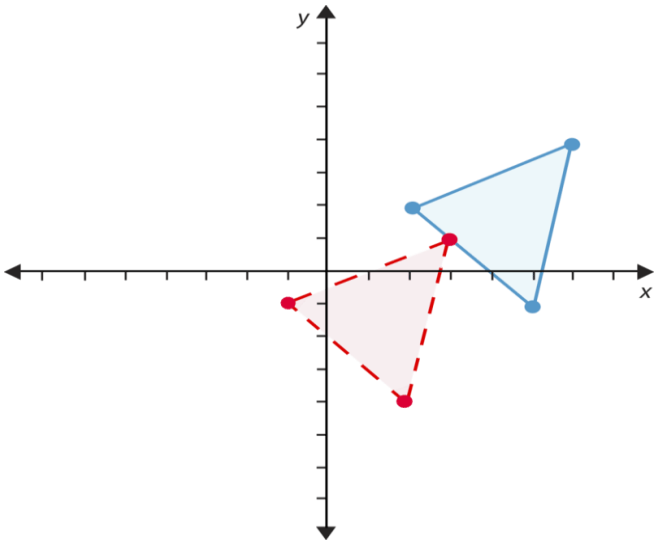


(8.)

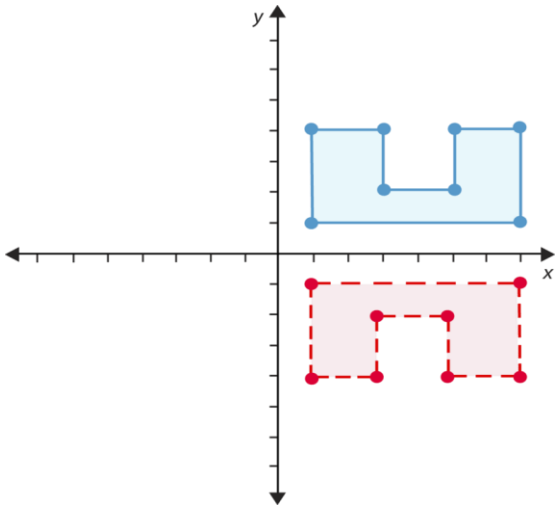
9. True or false: This figure has been translated 7 places to the right.



10. True or false: The image below is a picture of a reflection.



11. True or false: The image below is a picture of a reflection.



12. True or false: The figure below has been rotated 180 degrees.