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| **Unit** | **G1** |
| **Title** | Rigid Motions |
| **Mathematical Goals** | Students will…   * Know and be able to use precise definitions of geometric terms [G.CO.1] * Make formal geometric constructions sited in standards both by hand and using geometry software [G.CO.12, G.CO.13] * Given a geometric figure and a rotation, reflection and translation draw the transformed figure [G.CO.5] * Understand and explain the formal definition of rotation, reflection and translation [G.CO.4] * Represent transformations in the plane and describe transformations as functions that take points in the plane as inputs and give other points as outputs [G.CO.2] * Describe the rotations and reflections that carry given quadrilaterals and regular polygons onto themselves [G.CO.3] * Prove that the measures of the interior angles of a triangle sum to 180-degrees [G.CO.10] |
| **Target Standards** | **G.CO.1, G.CO.2, G.CO.3, G.CO.4, G.CO.5, G.CO.12, G.CO.13** |
| ***The story before this unit (including prior knowledge)*** | In middle schools, students were introduced to the concepts of rotation, reflection and translation in the context of hands-on activities. Students also worked with determining distances in the coordinate plane using Pythagorean theorem so they have some experience with coordinate geometry. |
| ***The part of the story happening in this unit*** | In this unit, the focus is on expanding and precisely defining many of the topics that students were exposed to in middle school. Students construct, by hand and using technology, perpendicular lines, parallel lines, equilateral triangle, square, etc. and develop formal definitions of these concepts through the constructions. Additionally, students formalize their definitions of rigid motions and they continue to perform single transformations in the plane (for standard G.CO.5, the emphasis in this unit is on single rigid motions; the first part of this standard). Students also examine rigid motions on the coordinate plane and understand that transformations act as functions that take points in the plan as inputs and give other points as outputs. |
| ***The story after this unit*** | In G2, students define and practice congruence through sequences of rigid motions. Students will address in great detail the second part of standard G.CO.5 in the G2 unit when they use sequences of rigid motions in the study of congruence. Additionally, students will continue to see geometric constructions throughout the following geometry units. |

**UNIT FLOW SUMMARY**

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| **UNIT G1** (18 - 21+ days) | **Rigid Motions** |
| **Section 0** (1 day) | **Diagnostic Pre-Unit Assessment** |
| **Section 1** (.5 days) | **Definitions and Geometry (hook/umbrella activity)** |
| **Section 2** (5 days) | **Introduction to Constructions** |
| **Section 3** (2 - 3 days) | **Representing Transformations** |
| **Section 4** (1 day) | **Mid-Unit Assessment** |
| **Section 5** (2 - 3 days) | **Coordinate Transformations** |
| **Section 6** (2 - 3 days) | **Polygon Symmetry** |
| **Section 7** (5+ days) | **Bringing it All Together** |
| **Section 8** (1 day) | **Summative Assessment** |

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| **Section 0:** 1 day | **Diagnostic Pre-assessment** |
| **Pre-Unit Assessment Targets** | Diagnose students’ ability to   * Draw geometric shapes with given conditions [7.G.A.2] * Recall and represent rotation, reflection and translation [8.G.A.1] * Describe the effects of rigid motions on two dimensional figures using coordinates [8.G.A.3] |
| **Sample Assessment Tasks** | [*Link to assessment*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsT3VCWWg0Nmh1TWM/edit) |



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| **Section 1:** .5 days | **Definitions and Geometry (hook/umbrella activity)** |
| **Mathematical Goal** | Students will...   * Recall and reconnect with geometry vocabulary that will be needed for this unit [G.CO.1] |
| **Narrative overview of section**  (and how the standards are achieved) | This geometry unit is heavy on vocabulary and definitions (students must know how to properly define a square in order to correctly construct one, etc.). Students saw some geometry in middle school but much time has passed since then so some of the specific may have been forgotten. The purpose of this unit is to allow students to reconnect and engage in the vocabulary that will be necessary for this unit and future geometry units. |
| **Sample Activity 1.1** | [*Geometry Vocabulary*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsZExmSGFFWW9FblE/edit), Jade White (High Tech High)  **WHAT:** In this activity, students will initially go through a list of several vocabulary words that will be necessary for this unit. After some time working independently, students will work in small groups to compare their thoughts and ideas about the given academic language. Teachers can choose how they want students to share out their ideas; perhaps through posters, presentations or group share-outs. The teacher will NOT go over all of the exact definitions at this time but will, as they appear throughout the unit, provide students with specific definitions and images for each word.  **WHY:** The purpose of this activity is to allow students to engage with the academic language needed in this unit G.CO.1 in a way that taps into their prior knowledge and provides a place to discuss and dialogue with their peers to activate their prior geometry experience. Further, the purpose of sprinkling in the exact definitions throughout the unit is to provide students an opportunity to learn the precise definitions in the context of the current activities they are working on MP.6. |
| **Target Standards** | G.CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. |
| **Mathematical Practices** | MP.6 |

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| **Section 2:** 5 days | **Introduction to Constructions** |
| **Mathematical Goals** | Students will...   * Learn how to use a compass and a straightedge to construct various geometric relationships and figures [G.CO.12, G.CO.13] * Learn how to use geometric software to construct various geometric relationships and figures [G.CO.12, G.CO.13] * Begin to understand the formal definitions of geometric relationships and figures through constructions [G.CO.12, G.CO.13] |
| **Narrative overview of section**  (and how the standards are achieved) | In this section, students are introduced to constructions both by hand and using geometric software. Students begin their understanding of precise definitions and concepts through proper constructions. Students initially use a compass and a straightedge to construct various geometric relationships and figures and then construct the same relationships and figures using geometric software.  As students build their formal definitions and move into transformations later in this unit, students will be able to use the foundations in constructions from this section to support, analyze and explain their work. |
| **Sample Activity 2.1** | [*Introduction to Constructions*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsN1prb0d5VHpidkU/edit), Jade White (High Tech High)  **WHAT:** In this activity, the teacher leads the class through six basic constructions; copying a segment, copying an angle, parallel and perpendicular lines, angle and line bisectors G.CO.12. All constructions here are done by hand without using geometric software. As the teacher leads the constructions, students write and construct along with the teacher, with the emphasis being on student written notes that make sense to them.  **WHY:** The six basic constructions here are the foundation for all other constructions students will see in this unit and later geometry units. The purpose of this activity is to provide students with a teacher guided foundation of constructions this will allow students to build a solid construction before moving on to further constructions. Additionally, students learn to use geometric tools for constructions MP.5, helping them to develop and understand how the tools can be used for for later geometric work. |
| **Sample Activity 2.2** | [*Pizza Delivery Region*](http://illuminations.nctm.org/Lesson.aspx?id=2688)*,* NCTM Illuminations  **WHAT:** In this task, students are given the task of dividing up a town into pizza delivery regions. The pizza company has 5 locations and in order to minimize delivery time, they want to divide the city into regions that would allow each customer to have pizza delivered to them from the nearest pizzeria location. While the final part of this task has 5 pizzeria locations, there are examples for 2, 3, and 4 locations as well to help build the necessary understanding and modeling needed to divide the city grid appropriately for 5 locations MP.4.  **WHY:** The trick to this task is in constructing perpendicular bisectors G.CO.12 between locations to ensure customers receive pizzas from the nearest location. By starting with the model of only 2 pizzeria locations, it is more easily seen that the perpendicular bisector appropriately splits the region. Students must notice this structure MP.7 and figure out how to apply it to the next models in order to precisely MP.6 divide the city grid for the pizza company. |
| **Sample Activity 2.3** | [*Constructing Shapes*](https://docs.google.com/a/hightechhigh.org/document/d/1iy8_MzljW-Cr0nq5wogy5KUDsfWf6QAr4rBjxe4XwQ8/edit), Jade White (High Tech High)  **WHAT:** In this task, students are presented with the challenge of figuring out how to construct an equilateral triangle, square, rectangle, hexagon and dodecagon G.CO.13. It is recommended that the teacher walk through the construction of the equilateral triangle, emphasizing the fact that the radius of a circle is always the same to help launch the students into the constructions of the additional figures. All constructions here are done by hand without using geometric software. Additionally, students must know and be familiar with the exact definitions of these shapes before constructing them.  **WHY:** This activity directly builds on [Introduction to Constructions](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsN1prb0d5VHpidkU/edit) but here students are not led by the teacher through the constructions. Students must build on the ideas from the previous activity to make sense of the problem at hand MP.1 and must attend to precision in explaining why their construction makes the given shape based on how it was constructed and how this connects to the definition of the figure MP.6. |
| **Sample Activity 2.4** | [*Constructing digitally*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsOFN1UGxUT2txTmc/edit)*,* Jade White (High Tech High)  **WHAT:** Students have now constructed several geometric properties and figures by hand. In this activity, students use their ideas from [Constructing Shapes](https://docs.google.com/a/hightechhigh.org/document/d/1iy8_MzljW-Cr0nq5wogy5KUDsfWf6QAr4rBjxe4XwQ8/edit) and construct the same figures using geometric software G.CO.12 G.CO.13. The teacher can demonstrate some of the key features of the software (parallel lines, perpendicular lines, line bisectors, etc.) and then allow the students to explore and discover how to construct the shapes on their own. When students have constructed the given shapes, they all must pass the “drag test” in order to be considered properly constructed (i.e. parallel & perpendicular lines must be used to construct the square and all sides must always remain the same length in order for the square to pass the “drag test”).  **WHY:** The purpose of this activity is to get students acquainted with geometric software (if they are not already) through geometric constructions. Students use their prior knowledge of how to construct the given figures by hand to understand how to use geometric software MP.5. |
| **Target Standards** | G.CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.  G.CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. |
| **Mathematical Practices** | MP.1, MP.4, MP.5, MP.6, MP.7 |

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| **Section 3:** 2 - 3 days | **Representing Transformations** |
| **Mathematical Goals** | Students will...   * Students can rotate, reflection and translate given geometric figures by hand [G.CO.5] * Students can rotate, reflection and translate given geometric figures using geometric software [G.CO.5] * Students develop definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments [G.CO.4] |
| **Narrative overview of section**  (and how the standards are achieved) | In middle school, students first explored rigid motions. Much of what was done in middle school with rigid motions was done experimentally (8.G.A.1); the purpose of this section is to formalize these understandings. Students will practice performing rigid motions using various tools (constructions, tracing paper, patty paper, technology, etc.) in order to formalize their understanding of this transformations. In this section, students focus on single transformations, developing definitions in terms of angles, circles, perpendicular lines, parallel lines and line segments. |
| **Sample Activity 3.1** | [*MATH*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CscllNeVdycTNVeEU/edit)*,* Jade White (High Tech High)  **WHAT:** In this activity, students perform single rigid motions G.CO.5. It is not explicitly explained how students complete the transformations except that they are to be completed by hand (not using technology); students must use appropriate tools strategically MP.5.  **WHY:** The purpose of this task is to provide the teacher with insight about their students’ prior understanding of how to rotate, reflect and translate a given figure. For the first three problems, students must complete the required transformation while on the fourth problem, students must experiment to find a rigid motion that satisfies the given condition. In order to complete the fourth problem, students must look for and make use of structure found in the previous problems MP.7. |
| **Sample Activity 3.2** | [*Transforming a Pentagon*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsdmNIR1RmYkJRZVE/edit) *&* [*Answer Key*](https://drive.google.com/file/d/0B8R6w4hGPNNHR2dNMWx1RC03Sm8/edit?usp=sharing)*,* Kristin Umland and Jade White (High Tech High)  **WHAT:** This is a practice activity in which students perform given rigid transformations on a given figure G.CO.5. An isometric grid scaffolds the mechanics of the transformations, so that students can focus on visualizing and drawing the image without having to perform constructions. To provide an additional scaffold, students could trace the pre-image on patty paper, and manipulate the traced pentagon to negotiate the location of the image before committing it to paper.  **WHY:** Students who are well-versed in the effects of various transformations from middle school may not need an activity like this. It is placed here in case students still struggle with visualizing given transformations and need more practice; this can provide students with an opportunity to demonstrate repeated reasoning and regularity in transformations MP.8. |
| **Sample Activity 3.3** | [*Reflected Triangles*](https://www.illustrativemathematics.org/illustrations/31)*,* Illustrative Mathematics  **WHAT:** In this task, students are given an original image (triangle) and the reflected image G.CO.5. Students are asked to construct the line of reflection using a compass and a straightedge.  **WHY:** Thus far, students have been provided with an original image and the line of reflection and they have been asked to reflect the given figure. This activity has students demonstrate their understanding of the line of reflection as the perpendicular bisector G.CO.4 G.CO.12 between any two corresponding points as well as a precise and accurate construction of a perpendicular bisector MP.6. |
| **Sample Activity 3.4** | [*Defining Reflections*](https://www.illustrativemathematics.org/illustrations/1510)*,* Illustrative Mathematics  **WHAT:** In this task, students are given a text book definition of reflection as well as a sample student definition. Students are asked to analyze the two definitions, explaining what is helpful about each. Because of the use working with the technical mathematical definition here, students must attend to precision and communicate clearly in their explanations MP.6; students should also notice that the given student definition is flawed because of its lack of precision.  **WHY:** At this point in the unit, students should be very familiar with the visual representation of reflection and should be able to use this task to help them transition to the technical mathematical definition of reflection G.CO.4. As stated in the IM task commentary “This task requires time and patience and is ideally suited for in class group work. If there are mirrors present in the classroom the teacher may wish to have students experiment so that they can see first-hand how the mirror image is similar and how it differs from the original. They should also test their intuition for the mirror image of figures by folding (relatively transparent) paper.” Students can use various tools MP.5 to help them in understanding and analyzing the given definitions. |
| **Sample Activity 3.5** | [*Defining Rotations*](https://www.illustrativemathematics.org/illustrations/1509)*,* Illustrative Mathematics  **WHAT:** In this task, students are given four possible definitions for rotation. They are asked to explain which, if any, of the provided definitions are a valid mathematical definition of rotation G.CO.4.  **WHY:** At this point in the unit, students should be very familiar with the visual representation of rotation and should be able to use this task to help them transition to the technical mathematical definition. By providing four possible definitions and having students work through the validity and precision of each, the work in this task exemplifies MP.6. |
| **Sample Activity 3.6** | [*Sum of Angles in a Triangle*](https://www.illustrativemathematics.org/illustrations/1923)*,* Illustrative Mathematics G.CO.10  **WHAT:** In middle school, students “use informal arguments to establish facts about the angle sum and of triangles” (8.G.A.5). In this activity, students use single rotations to deduce that the sum of the interior angles of a triangle is 180-degrees G.CO.10.  **WHY:** From the IM site, “The goal of this task is to provide an argument, appropriate for high school students, for why the sum of the angles in a triangle is 180 degrees. Here students use the formal properties of rotations (namely that they preserve angle measures) to deduce that the sum of the angles in the triangle is 180 degrees.” |
| **Target Standards** | G.CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.  G.CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.  G.CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line. |
| **Mathematical Practices** | MP.5, MP.6, MP.7, MP.8 |

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| **Section 4:** 1 day | **Diagnostic Mid-assessment** |
| **Pre-Unit Assessment Targets** | Assess students’ ability to   * Make formal geometric constructions (copying a segment) G.CO.12 * Construct a square G.CO.13 * Given a geometric figure and a rotation, reflection or translation draw the transformed figure G.CO.5 * Understand and explain the formal definition of rotation G.CO.4 |
| **Sample Activity** | [Mid-Assessment](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsZ3p5cW5MLUMwaEE/edit) |

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| **Section 5:** 2-3 days | **Coordinate Transformations** |
| **Mathematical Goals** | Students will...   * represent transformations in the plane using various tools (transparencies, geometry software, etc.) [G.CO.2] * describe transformations as functions that take points in the plane as inputs and given other points as outputs [G.CO.2] * compare transformations that preserve distance and angle and those that do not (translation vs. horizontal stretch) [G.CO.2] |
| **Narrative overview of section**  (and how the standards are achieved) | In this section, students apply the ideas of transformations on a coordinate plane. Students will complete a rigid motion then define the motion as a function, noticing the consistent change in input/output values for translations, rotations, and reflections. |
| **Sample Activity 5.1** | [*Transforming 2D Figures*](http://map.mathshell.org/materials/lessons.php?taskid=524&subpage=concept), MARS  **WHAT:** In this activity, students work collaboratively to describe given transformations as well as completing the given transformations by either representing the transformed figure or the original figure G.CO.5. Because students saw transformations in middle school, this task provides an opportunity for students to build on and expand their prior knowledge of geometric transformations.  **WHY:** The purpose of this task is for students to begin to see transformations in different means. Students describe transformations through writing and images and also see transformations as functions that take points in the plane as inputs and give other points as outputs G.CO.2. The multiple representations of transformations provided here allows the students to look for and make use of structure MP.7 in transformations. Students must make sense of and persevere in working with the multiple representations and how to connect them together MP.1. Additionally, students must attend to precision MP.6 when completing the transformations in the various modes. |
| **Sample Activity 5.2** | [*Horizontal Stretch of the Plane*](https://www.illustrativemathematics.org/illustrations/1924)*,* Illustrative Mathematics  **WHAT:** In this activity, students perform maps *f* and *g* (independently) to triangle ABC and explain if each mapping preserved the given distances and angles G.CO.2.    **WHY:** The purpose of this task as explained in the task commentary is for students to “compare a transformation of the plane (translation) which preserves distances and angles to a transformation of the plane (horizontal stretch) which does not preserve either distances or angles.” To complete parts b. and c. of this task, students must explain their reasoning MP.2 about each mapping and why it either preserves or doesn’t preserve the given distances and angles. |
| **Target Standards** | G.CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).  G.CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. |
| **Mathematical Practices** | MP.1, MP.2, MP.6, MP.7 |

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| **Section 6:**  2 - 3 days | **Symmetry of Polygons** |
| **Mathematical Goals** | * Students understand the idea of reflectional symmetry [G.CO.4] * Students understand the idea of rotational symmetry [G.CO.4] * Given shapes (rectangle, parallelogram, trapezoid, regular polygon) students can describe the rotations and reflections that carry it onto itself [G.CO.4] |
| **Narrative overview of section**  (and how the standards are achieved) | In this section, students examine symmetry of polygons. Students experiment with rotation and reflection to identify what transformations can be used to map a polygon onto itself. |
| **Sample Activity 6.1** | [*Face Value*](http://mathalicious.com/lessons/face-off)*,* Mathalicious  **WHAT:**  In this activity students examine symmetry in faces. Specifically, students first examine the faces of four celebrities by reflecting points over the line of symmetry for each face G.CO.5; the reflected points would represent the perfect reflection location if a face were truly symmetrical. Students notice from the first four examples that most faces are not perfectly symmetrical. Thus, the remainder of the task has students measure the differences from the reflected point location to the actual facial feature location to calculate a “symmetry score.” Additionally, students calculate a symmetry score of a zoomed in vs. zoomed out face to notice what other factors might affect the symmetry score.  **WHY:** This activity provides a great setting to introduce the idea of symmetry. Students should be familiar with reflection and constructing reflected points using perpendicular bisectors G.CO.4. Here students are provided with an opportunity to grapple with the idea of something being symmetric and reflecting onto itself and must persevere through the calculations and analysis of the symmetry score MP.1. This activity also provides students with an opportunity to model the ideas facial symmetry through reflection MP.4. |
| **Sample Activity 6.2** | [*Seven Circles II*](https://www.illustrativemathematics.org/illustrations/708)*, Illustrative Mathematics*  **WHAT:** In this problem, students examine a pattern of seven circles; one in the center with six equal sized circles around the center circle. Students are asked to find as many rigid motions as possible which are symmetries of this given configuration of circles G.CO.3.  **WHY:** As stated in the activity commentary, this “task is intended primarily for instructional purposes. It provides a concrete geometric setting in which to study rigid transformations of the plane. It is important for students to be able to visualize and execute these transformations.” This activity provides a good instructional introduction to the more specific symmetries they will soon study. |
| **Sample Activity 6.3** | [*Symmetries of Quadrilaterals I*](https://www.illustrativemathematics.org/illustrations/1471)*, Illustrative Mathematics*  **WHAT:** In this activity, students are given specific details about rigid motions that map a certain quadrilateral onto itself G.CO.3. With this information, students must identify which quadrilateral is being described. Students must know and be familiar with specific definitions for different quadrilaterals before attempting this problem.  **WHY:** This activity provides a great avenue for students to examine the definitions of different quadrilaterals through rigid motions. Additionally, students can experiment, using different geometric tools (software, transparencies, patty paper, etc.) the rotations of various quadrilaterals MP.5. |
| **Sample Activity 6.4** | [*Symmetries of Rectangles*](https://www.illustrativemathematics.org/illustrations/1469)*, Illustrative Mathematics*  **WHAT:** In this activity, students examine the rotations and reflections of two rectangles; the first rectangle is identified as ABCD. In part b., students must identify that the rigid motions of the rectangle from part a. apply to all rectangles, that is unless the rectangle is in fact a square.  **WHY:** The purpose of this problem is to provide students with an opportunity to explore and discover all reflections and rotations that map a rectangle onto itself G.CO.3. It is explicitly not given how many possible rigid motions there are so students must construct a viable argument to support their findings MP.3. From the constructions in section 2 of this unit, students should be familiar with the similarities and differences between rectangles. Additionally, through the vocabulary, students should know precise definitions of rectangles and squares along with an understanding of the taxonomy of quadrilaterals. This problem provides students an opportunity to look for and make use of structure “since one way to create new rigid motions preserving *ABCD* is to compose rigid motions already shown to preserve the rectangle” MP.7. |
| **Sample Activity 6.5** | [*Symmetries of Quadrilaterals II*](https://www.illustrativemathematics.org/illustrations/1470)*, Illustrative Mathematics*  **WHAT:** In this activity, students are given specific details about rigid motions that map a certain quadrilateral onto itself G.CO.3. With this information, students must identify which quadrilateral is being described. Students must know and be familiar with specific definitions for different quadrilaterals before attempting this activity. This is very similar to [*Symmetries of Quadrilaterals I*](https://www.illustrativemathematics.org/illustrations/1471) except there are more restrictions given in this activity.  **WHY:** This activity provides a great avenue for students to examine the definitions of different quadrilaterals through rigid motions. Additionally, students can experiment, using different geometric tools (software, transparencies, patty paper, etc.) the rotations of various quadrilaterals here MP.5. In order to completely solve this problem, students must divide and analyze several possible cases for the line of reflection. This requires students to reason abstractly and quantitatively MP.2 as well as evaluat and understand the results from the different cases MP.8. Further because of the complexity and natural division into cases, this task is recommended for group work (from IM website). |
| **Target Standards** | G.CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.  G.CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.  G.CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. |
| **Mathematical Practices** | MP.1, MP.2, MP.3, MP.4, MP.5, MP.7, MP.8 |

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| **Section 7:** 5+ days | **Bringing it All Together** |
| **Mathematical Goals** | * Students create a given design through construction and rigid motions [G.CO.12, G.CO.13, G.CO.5] |
| **Narrative overview of section**  (and how the standards are achieved) | In this section of the unit, students demonstrate a synthesis of constructions and rigid motions through the creation of art pieces. |
| **Sample Activity 7.1** | [Nepal Flag](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5Csb3lZOEJsdHNBeUU/edit), Jade White (High Tech High)  **WHAT:** It is written into the constitution of Nepal the construction for how to make the country flag. Here, students are given the steps for the construction and following along precisely and accurately MP.6, are able to reproduce the Nepal flag. This activity can be done by hand using a compass and straightedge or digitally using geometric software allowing students to demonstrate how they can use appropriate tools strategically MP.5.  **WHY:** The steps given in the Nepal constitution are specific enough to follow but do require a level of perseverance MP.1 and abstract/quantitative reasoning MP.2 in order to construct the entire flag. The purpose of this task is to give students an opportunity to both construct G.CO.12 G.CO.13 and perform rigid motions G.CO.5 simultaneously in order to get to a sound final product. Additionally, students demonstrate knowledge of precise definition G.CO.1 through their comprehension of the instructions.  Example of a completed Nepal Flag in [SketchPad](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsemNHQTNvQ1c0ZWs/edit) |
| **Sample Activity 7.2** | [Geometric Art](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsQnZ1YjZZRFlfSjQ/edit), Jade White (High Tech High)  **WHAT:** This activity builds off of the [Nepal Flag](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5Csb3lZOEJsdHNBeUU/edit) activity above. Here, students create their own art piece using constructions G.CO.12 G.CO.13 and rigid motions G.CO.5 both by hand and digitally MP.5. As explained here, this project can take multiple weeks but can easily be adapted to a shorter time frame as needed. Additionally, the art piece is not set in the coordinate plane but this level could be added to provide students with extra practice describing transformations as function G.CO.2. The third phase of this project has students write instructions (similar to the Nepal constitution) describing their art piece.  **WHY:** This activity provides students with an opportunity to model and be creative in the geometry math setting MP.4. Students demonstrate sound knowledge of constructions and rigid motions through the design and explanation of their art piece; they must make sense of the requirements MP.1 and reason through how to use these to make a beautiful piece of art MP.2. The writing and peer edit process allows students to articulate and communicate precisely MP.6 in order to make cohesive and understood instructions for their art piece. |
| **Target Standards** | G.CO.1, G.CO.2, G.CO.5, G.CO.12, G.CO.13 |
| **Mathematical Practices** | MP.1, MP.2, MP.4, MP.5, MP.6 |

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| **Section 8:** 1 day | **Summative Assessment** |
| **Pre-Unit Assessment Targets** | Assess students’ ability to   * Define specific geometric terms G.CO.1 * Make formal geometric constructions (parallel and perpendicular lines) G.CO.12 * Construct a square and explain why the construction yields such G.CO.13 * Given a geometric figure and a rotation, reflection or translation draw the transformed figure G.CO.5 * Understand and explain the formal definition of rotation G.CO.4 * Describe transformations as functions G.CO.2 * Given a square and trapezoid, describe the rotations and reflections that map it onto itself G.CO.3 |
| **Sample Activity** | [*Summative Assessment*](https://docs.google.com/a/hightechhigh.org/file/d/0B784Ztw6k5CsMlNrTlpoVW0yVWM/edit) |

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|  | 1.1 | 2.1 | 2.2 | 2.3 | 2.4 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 5.1 | 5.2 | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 7.1 | 7.2 |
| G.CO.1 | **X** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** |  |
| G.CO.2 |  |  |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |  |  |  | **X** |
| G.CO.3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** | **X** | **X** | **X** |  |  |
| G.CO.4 |  |  |  |  |  |  |  | **X** | **X** | **X** |  |  |  | **X** |  |  |  |  |  |  |
| G.CO.5 |  |  |  |  |  | **X** | **X** | **X** |  |  |  | **X** |  | **X** |  |  |  |  | **X** | **X** |
| G.CO.10 |  |  |  |  |  |  |  |  |  |  | **X** |  |  |  |  |  |  |  |  |  |
| G.CO.12 |  | **X** | **X** |  | **X** |  |  | **X** |  |  |  |  |  |  |  |  |  |  | **X** | **X** |
| G.CO.13 |  |  |  | **X** | **X** |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** | **X** |

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|  | 1.1 | 2.1 | 2.2 | 2.3 | 2.4 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 5.1 | 5.2 | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 7.1 | 7.2 |
| MP.1 |  |  |  | **X** |  |  |  |  |  |  |  | **X** |  | **X** |  |  |  |  | **X** | **X** |
| MP.2 |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  | **X** | **X** | **X** |
| MP.3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** |  |  |  |
| MP.4 |  |  | **X** |  |  |  |  |  |  |  |  |  |  | **X** |  |  |  |  |  | **X** |
| MP.5 |  | **X** |  |  | **X** | **X** |  |  | **X** |  |  |  |  |  |  | **X** |  | **X** | **X** | **X** |
| MP.6 | **X** |  | **X** | **X** |  |  |  | **X** | **X** | **X** |  | **X** |  |  |  |  |  |  | **X** | **X** |
| MP.7 |  |  | **X** |  |  | **X** |  |  |  |  |  | **X** |  |  |  |  | **X** |  |  |  |
| MP.8 |  |  |  |  |  |  | **X** |  |  |  |  |  |  |  |  |  |  | **X** |  |  |