

5E Integrated STEM Lesson Plan

Lesson Title: *An Astronaut in Motion*

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Topic: *Transformations, Translations and Reflections*

Targeted Grade Level: *9th/10th Grade (Geometry)*

Time Needed: 75 minutes or two class periods

Subject Integration: *Math, Science, and Physical Education*

Justification: In mathematics (specifically Geometry), students will investigate how NASA researchers are able to simulate an astronaut's movement in space by applying transformation principles. In science, students will study and predict how the motion of orbiting objects is affected in the solar system. In Physical Education classes, students will practice different movements on the floor based on specific transformations.

Standards:

NGSS Performance Expectations

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
ESS1.B: Earth and the Solar System Kepler's laws describe common features	ESS1.B: Earth and the Solar System Kepler's laws describe common	<i>Scale, Proportion, and Quantity</i> <i>Algebraic thinking is used to examine</i>

<p>of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other obj</p>	<p>features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other obj</p>	<p><i>scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4)</i></p> <p><i>Interdependence of Science, Engineering, and Technology Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HSESS1-2),(HSESS1-4)</i></p>
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Common Core State Standards:

MATH

KY.HS.G.2 Representing transformations in the plane.

- a. Describe transformations as functions that take points in the plane as inputs and give other points as outputs
- b. Compare transformations that preserve distance and angle measures to those that do not.
- c. Given a rectangle, parallelogram, trapezoid, or regular polygon, formally describe the rotations and reflections that carry it onto itself, using properties of these figures.

KY.HS.G.3 (+) Develop formal definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments

KY.HS.G.4 Understand the effects of transformations of geometric figures.

- a. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure.
- b. Specify a sequence of transformations that will carry a given figure onto another.
- c. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure. Given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

SCIENCE

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

PHYSICAL EDUCATION

HS.S2.1. Use movement concepts and principles to analyze and improve performance of self and/or others

Measurable Student Learning Objectives:

1. Students will be able to apply translations in the coordinate plane.
2. Students will be able to apply reflections over the x- and y-axis in the coordinate plane.
3. Students will be able to determine locations on the coordinate plane based on specific transformations.
4. Students will be able to apply multiple transformations to a single object on the coordinate plane.

Assessment : There are numerous formative assessments throughout this lesson. In each section there are formative assessments based on group responses. In the final section, there is a summative assessment and students will be given a grade based on their independent answers from questions 15-17.

Nature of STEM: This lesson provides many opportunities to connect to the standards for mathematical practice. Below are the specific standards that the lesson connects with.

- Make sense of problems and persevere in solving them.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.

Engaging Context/Phenomena: My “hook” for this lesson will be a video of how astronauts move in space. Link: <https://www.youtube.com/watch?v=AmrrSfiMxGA>

Students will then read the background lesson in groups of three or four and discuss thoughts with one another.

Data Integration: Students will be using the TI Inspire to read through problem sets and explore various movements on the figures on the screen. They will use that throughout their lessons to record their data of points based on transformations. The lesson can be found here: https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf

Differentiation of Instruction: Within this lesson, I will group students prior to completing this. In one of my classes I will utilize my special education teacher to have her own group and work with the students through the problems. These students may only get to one transformation. For my advanced students I will have them choose harder points and do multiple transformations within the problems.

Real-life Connection: This lesson provides opportunities for students to see how transformations can be applied and manipulated on Earth to help those that are in space.

Possible Misconceptions: The main misconceptions from this lesson will come from being able to properly read a coordinate plane and what happens when you have negative coordinates. There could also be misconceptions that there

is only one correct answer when doing multiple transformations. When students begin calculating they will see there may be multiple correct answers.

Lesson Procedure :

5E Model	5E Objectives
<p><u>Engage</u> (20 minutes)</p>	<p>Procedure: We will start the class by watching the NASA Astronauts Space Walk Outside the ISS (https://www.youtube.com/watch?v=AmrrSfiMxGA) video which is 10 minutes long.</p> <p>Once the video is complete, students will read over the Background section of An Astronaut in Motion. After a couple of minutes, students will get in groups of three to four and discuss the main points of the Background section for five minutes to be sure that they understand the material. The students will write down two main points of the section. We will discuss the main points and then determine the top three that we feel are most important.</p> <p>Some focus questions include:</p> <ol style="list-style-type: none"> 1. What are the main components of the system? 2. On what are the actor's movements being displayed? 3. What are some other possible applications for the use of this software for NASA? <p>Modifications: Students will be grouped prior to the lesson so that all students can be successful. The special education teacher will be assisting me and can read the background out loud if needed.</p> <p>Standards Addressed: During this section students are mainly using their prior knowledge of movement concepts and exercising to compare and contrast exercising on Earth versus in space. The standard addressed would be a Physical Education Standard (HS.S2.1. Use movement concepts and principles to analyze and improve performance of self and/or others).</p>

	<p>Formative/Summative Assessments: The formative assessment will be determined by group success. Each group will be required to share their group consensus summary of the background sections to prove their engagement in the reading.</p> <p>Resources: The teacher will need some type of technology to display the video and will need to make copies of the NASA provided, “Exploring Space Through Math: Applications in Geometry” Packet. https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf</p>
<p>Explore (10 minutes)</p>	<p>Procedure: Allow students to remain in their groups. Distribute the TI-Nspire file: Astronaut_Motion.tns to the students’ handhelds.</p> <p>Have students read the problem setup and directions, and then answer the questions on pages 1.2-3.6.</p> <p>Modifications: Have examples and walk-through with those struggling with grasping the concept and answering the questions.</p> <p>Standards Addressed:</p> <ul style="list-style-type: none">● KY.HS.G.2: Representing transformations in the plane.● KY.HS.G.3: Develop formal definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments <p>Formative/Summative Assessments: The formative assessment will be determined by group success. Each group will be required to share their answer for pages 1.2-3.6.</p> <p>Resources: TI Nspire Calculator and copies of the material. https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf</p>

<p><u>Explain</u> (15 minutes)</p>	<p>Procedure: At this time students will be allowed to remain in their groups to read directions and answer questions on pages 4.1-4.5. Once they have finished I will be calling on students to give their answers and discuss.</p> <p>Modifications: I will give the students a formula sheet that gives shortcuts to the transformations. If they choose to use those to make their calculations go faster they are welcome to. For some students, having a 'formula' makes understanding transformations much easier.</p> <p>Standards Addressed:</p> <ul style="list-style-type: none">● KY.HS.G.2: Representing transformations in the plane.● KY.HS.G.3: Develop formal definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments <p>Formative/Summative Assessments: Since this step is done in groups it will be easy to roam the room and check for accuracy as we go. Ultimately if students have the last question correct the rest of the questions will also be correct because of the scaffolding model the questions are built in.</p> <p>Resources: TI Nspire Calculator and copies of the material. https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf</p>
<p><u>Elaborate</u> (15 minutes)</p>	<p>Procedure: Students will continue to stay in groups to read the directions and answer the questions on pages 5.1-5.8. Student discussion will be encouraged and I will continuously walk around the room to ask questions as students are exploring.</p> <p>Modifications: While students are working I will actively monitor and take any steps for extension or scaffolding that I notice students need. Students who needed formula sheets for the previous section will also be able to use their formula sheets during this time.</p> <p>Standards Addressed:</p> <ul style="list-style-type: none">● KY.HS.G.2: Representing transformations in the plane.● KY.HS.G.3: Develop formal definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments.

	<ul style="list-style-type: none">● KY.HS.G.4: Understand the effects of transformations of geometric figures. <p>Formative/Summative Assessments: Once students are finished answering their questions, I will split them up in new groups to compare answers. I will be walking around the room to check for understanding and asking questions to evaluate them.</p> <p>Resources: TI Nspire Calculator and copies of the material. https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf</p>
<p><u>Evaluate</u> (15 minutes)</p>	<p>Procedure: For the evaluate section of the lesson, I will Have students work independently to read the directions and answer questions on page 6.1-6.6. I will distribute a piece of graph paper to students to complete the question on page 6.7. I will collect all student work at the end of class to look over. I will address any misconceptions in class the following day.</p> <p>Modifications: In the chance that a student does not get finished in the allotted time I will allow them to take the assignment home and bring it back the next day. The downfall with this would be not getting to look at it and make plenty of feedback on the paper. However, for students who work slower it might be a more effective approach for them.</p> <p>Standards Addressed:</p> <ul style="list-style-type: none">● KY.HS.G.2: Representing transformations in the plane.● KY.HS.G.3: Develop formal definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments● KY.HS.G.4: Understand the effects of transformations of geometric figures. <p>Formative/Summative Assessments: Students grade will be based on questions 6.1-6.7.</p> <p>Resources: TI Nspire Calculator and copies of the material and graph paper. https://www.nasa.gov/pdf/585029main_Astonaut_Motion_ST.pdf</p>

Teacher Background: Students should have prior knowledge of the coordinate plane and basic navigation of the TI-Nspire™ handheld. Teacher edition of lesson plan can be found here:
https://www.nasa.gov/pdf/585030main_Astronaut_Motion_ED.pdf