5E Integrated STEM Lesson Plan.

Lesson Title: *Exploring Exoplanets with Algebra*

Author: Samantha Todres

Topic: Numbers and Operations

Targeted Grade Level: *9 -12 (Algebra II)*

Time Needed: 1 class period

Subject Integration: Math, Technology, and Science (Earth science)

Justification: What is great about this specific lesson is that it takes science (earth science for NY), and works it into Algebra II. This is great for several reasons, one being that students get to see other work from science classes pop up into their math classes and see how they are connected. Students also have the opportunity to show off what they know and bring in outside knowledge to help further the class discussions and give the problem more context. Teachers are giving their students opportunities to reinforce what they learn in one class, in another. Students also have the chance to connect mathematics with earth science and technology, specifically, they can see how we use mathematics to understand different features of exoplanets.

Standards: HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system
HSF.BF.B.5: Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
HSF.LE.A: Distinguish between situations that can be modeled with linear functions and with exponential functions.
HSN.RN.A.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.
HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays

NGSS Performance Expectations

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 4. Analyzing and interpreting data 5. Using mathematics and computational thinking **MSESS1-3 - Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ■ Develop and use a model to describe phenomena. (MS-ESS1-1),(MS-ESS1-2) Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of**	**ESS1.A: The Universe and Its Stars ■ Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) ■ Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2) ESS1.B** **Earth and the Solar System ■ The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1- 2),(MS-ESS1-3)** **This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The seasons are a**	1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. 3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. **Patterns - Patterns can be used to identify cause and effect relationships. (MS-ESS1-1) Scale, Proportion, and Quantity ■ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1- 3)**

data and error analysis. ■ Analyze and interpret data to determine similarities and differences in findings.	**result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. ■ The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)**	**Systems and System Models - Models can be used to represent systems and their interactions. (MS-ESS1-2)** **Connections to Engineering, Technology, and Applications of Science Interdependence of Science, Engineering, and Technology - Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MSESS1-3)**

Common Core State Standards:

Math:

HSF.BF.B.5: Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
HSF.LE.A: Distinguish between situations that can be modeled with linear functions and with exponential functions.
HSN.RN.A.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.
HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays

ITEEA Standards

Other Standards:

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

Measurable Student Learning Objectives: *SWBAT fill in missing items of a table using conversions, Kepler's Law, and graphs.*

Nature of STEM: This lesson addresses the Nature of Math by having students ask questions and inquire based on different data given to them and looking at data to find the missing parts. This lesson address the Nature of Science by enhancing students understanding of exoplanets and the different characteristics of them. This lesson also addressed the Nature of Technology because students will be using technology with a purpose to explore exoplanets as a reminder to what they are and how and why transits happen.

Engaging Context/Phenomena: The engaging Phenomena or hook of this lesson are transits that happen in space due to planets passing by the sun. We will also watch this video: https://www.youtube.com/watch?v=FLq8CJ5HQwE&t=2s of an exoplanet transit.

Data Integration: For this lesson, data collected from NASA and published on the NASA STEM Engagement site is being used. Specifically the data collected showing the change in brightness from transits happening with different exoplanets. For this lesson, students are analyzing data to draw conclusions and fill in tables.
https://www.jpl.nasa.gov/edu/teach/activity/exploring-exoplanets-with-kepler/

Differentiation of Instruction: To meet the needs of unique students, I will modify this lesson by doing an example in class in case students get confused or stuck (and keep the example up on the board). I will also put students into heterogenous groupings so higher performing students can help out students in their groups who may need more support. Each group will also have roles each member needs to fulfill (calculator, communicator, and scribe) so each student is working and contributing to the group work.

Real-life Connection: There is a lot going on in the news with billionaires going into space and I think that would open an interesting conversation on equity in space exploration.

Possible Misconceptions: Students may be confused about transits and doing the conversions. To avoid this, I will explicitly go over transits and go over an example conversion.

Lesson Procedure:

5E Model	5E Objectives
Engage *Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.*	**Procedure:** *This is when students first walk in and is their Do Now – they will be asked to recall what a transit is. They are also encouraged to look it up if they don't remember. We will also watch a video of an exoplanet transit.* **Modifications** *For students who do not know or struggle to remember, they can look up what a transit is using a computer.* **Standards Addressed N/A** **Formative/Summative Assessments N/A** **Resources https://exoplanets.nasa.gov/faq/31/whats-a-transit/** **https://www.youtube.com/watch?v=FLq8CJ5HQwE&t=2s**
Explore *Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.*	**Procedure:** Students will use the example that the teacher goes through in class and their algebraic knowledge to complete the worksheet in groups. **Modifications** Students will work in heterogenous groupings for the activity **Standards Addressed** HSF.BF.B.5, HSF.LE.A, HSN.RN.A.2, HSA.CED.A.4, HS-ESS1-4 **Formative/Summative Assessments** Question #2 on the worksheet. **Resources https://www.jpl.nasa.gov/edu/pdfs/exoplanets_worksheet.pdf**
Explain *Facilitate opportunities for students to explain*	**Procedure:** During the example problem, after the teacher walks through one example ("I do") the students will be selected to answer the next row ("we do"). **Modifications** This is an opportunity for students who struggled to understand what to do the first time around to get an additional opportunity to understand the procedure from their peers. They can

their understanding of concepts and processes and make sense of new concepts.	and should ask questions and write down the correct responses. **Standards Addressed** HSF.BF.B.5, HSF.LE.A, HSN.RN.A.2, HSA.CED.A.4, HS-ESS1-4 **Formative/Summative Assessments N/A** **Resources N/A**
Elaborate *Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.*	**Procedure** After 20 minutes of work time, students will switch group members and share their responses with each other. This will offer an opportunity to check their answers, explain their though processes and challenge other's answers. **Modifications** Students will still be in heterogenous groupings for support and the teacher will walk around the room for additional supports.
Evaluate *Assess students knowledge, skills and abilities.*	**Procedure:** The teacher will grade table #2 to assess students' knowledge, skills and abilities.

Teacher Background: A math teacher needs to know what transits are (see resource in Engage section).