Unit Plan*

Name: Logan Brodsky	**Course Title: Algebra 1A**
Length: 4-6 Blocks (each 80 minutes long)	**Grade(s): 9-10**
Unit Plan Title: Exponents and Exponential Functions in our World	
Integration of NASA Resources/Data	
For this lesson, students will be exploring how exponents are used in the real-world. They will not only explore exponential functions, but how exponents influence other functions and their use in the real world. In the early stages of the unit, it will be much more mathematics based. Students will go through a series of activities that have them explore and form conjectures for the laws of exponents and Scientific Notation. They will also be able to express how an exponent is a mathematical operation that signifies repeated multiplication (the same way multiplication signifies repeated addition). Due to this notion of repeated multiplication, there will also be a development of the concept that exponents make numbers grow large very quickly. This concept will be explored with regular arithmetic for exponents and through multiple representations with Exponential and inverse Power functions. Later in the unit, we will use technological tools such as Desmos to explore the trajectory of an exponential function as well as the different components. Ultimately, we will use mathematical modeling, Science, and Technology to develop a model for a specific task with the NASA Psyche Spacecraft. This spacecraft will orbit the Sun, so it will use a complex system of Solar Energy to function. The spacecraft's task is to eventually land on an asteroid called 16 Psyche in the year 2029, and explore its terrain. Lastly, we will compare and contrast exponential functions with linear and inverse Power Functions, and solve real-world problems related to exponential functions. Some of the problems relate to NASA.	
Statement of Purpose	
This unit will integrate Math with Science and Technology. This will better enhance my students understanding of Math being the language we use to explain, justify, or make sense of Science. Technology is the tool that allows us to bond math with science. Science is the study of all the different physical and natural phenomenon in the world around us. It may be the case that the unit contains mostly math objectives, but learning math is pointless if you are not using it to solve problems in the physical or natural world around us. For instance, you can teach students about how exponents influence the trajectory of certain functions, but students will not develop a means to an end without a context. People learn better when they are given a reason to learn something because it gives them more meaning. Learning is not a transfer of information, it is a gradual and constructive process of making meaning. Furthermore, students need to struggle and grapple until a solution is reached and then they can draw conclusions and make revisions. This unit is developmentally appropriate for students because we are using New Jersey Student Learning Standards that are on par with their grade level, the tasks and math computation that students are given are suitable to their grade level and ability level, and each of the lessons have the necessary structure and supports in place to meet the needs of students.	

For instance, when exploring the involvement of exponents in inverse Power Functions, students will be guided through the mathematical modeling process and there will be carefully planned guided questions. When using technological tools such as Google Sheets, students will be given very detailed directions and will be shown how to use some features of Google Sheets. In terms of the mathematics, the exponent problems will not involve more than two difference bases. The computation involved with the functions will also not be too complex because none of the functions contain e, natural log, or trigonometry.

All of the skills students will develop are in this order: Properties of Exponents, Perfect Squares and Cubes, Fours Laws of Exponents, Scientific Notation, exponents in inverse Power Functions, and Exponential Functions. The first two skills are part of Lesson One, the third and fourth skill are for Lesson Two, the fifth skill is part of Lesson Three, and the last skill is for Lesson Four.

Each of the four lesson will use various methods of differentiation depending on the student body and formative assessment results. At the beginning of the unit, there will be a Pre-Assessment that students will complete on IXL. This will give me an idea of what students already know about Exponents from Middle School. The student results will determine who they sit next to during this unit, and I will also be mindful of these results for the duration of the unit. The default form of differentiation is for my students to sit in groups of two and work on tasks as a group of two. During Lesson One, some students will be assigned in one larger group to get more intensive instruction. During Lesson Two, students will be given a Do Now, and their score on this Do Now determines what group they are in. Each group will have different levels of support, but are working on the same task. For Lesson Three, the students will work on an Exploration activity in groups of four. For Lesson Four, the students will work in groups of two throughout the lesson. As we move along, some students will have tasks broken down into more manageable units, students will be designing/construction their own models for certain tasks, notes or answer keys might be provided to some students, and some students or groups might need more individualized instruction during their task.

NGSS Performance Standard

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

NJSLS Math Standards

8.EE.A.4: Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

HSN-RN.A.1: Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

HSN.SSE.B.3c: Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as (1.151/12)12t ≈1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

HSA-CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

HSF-IF.C.7e: Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

HSF-IF.C.8b: Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.

HSF-BF.B.3: Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

HSF-LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions.

HSS-ID.B.6a: Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context.

HFS-LE.A.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

HFS-LE.B.5: Interpret the parameters in a linear or exponential function in terms of a context.

Essential Question(s)

1. How do exponential functions differ from linear functions?
2. How can we describe or represent the rapid output growth for exponential functions?
3. How are exponential functions applied in important problems in space?
4. How does the application of exponential functions connect with science, technology, engineering, and even the arts?

Instructional Objectives

Lesson 1

With 97% accuracy, students will be able to express exponents as repeated multiplication through expansion, convert expanded notation to exponential notation, as well as converting to standard notation.

With 97% accuracy, students will be able to display perfect squares and cubes with the use of models and arithmetic.

Lesson 2

With 96% accuracy, students will be able to perform the computation for each the four laws of exponents (Product Rule, Quotient Rule, Zero Exponent Rule, and Negative Exponent Rule) to simplify both regular exponential expressions and ones in Scientific Notation.

Lesson 3

With 96% accuracy, students will be able to use the fundamentals of exponents and inverse square law to calculate solar power, collect data in a table, and then use the data to graph a Power function for solar power as a function of astronomical units (d).

With 96% accuracy, students will be able to analyze graphs and tables involving Power functions and describe trends in the data.

Lesson 4

With 96% accuracy, Students will be able compare and contrast Power Functions (with negative exponents), Linear Functions, and Exponential Functions using multiple representations. They will also identify the different transformations for Exponential Functions.

Lesson 1

5E's Addressed in Lesson 1: Engage, Explore, Explain, and Evaluate

Stages of Lesson

- **Instructional Outline:**
  1. Pre-Assessment Diagnostic on IXL.
  2. Engaging Videos
  3. Explore Perfect Squares and Cubes Activity
  4. 6.1 Notes
  5. 6.1 Exit Ticket

Description of Pre-Assessment Diagnostic

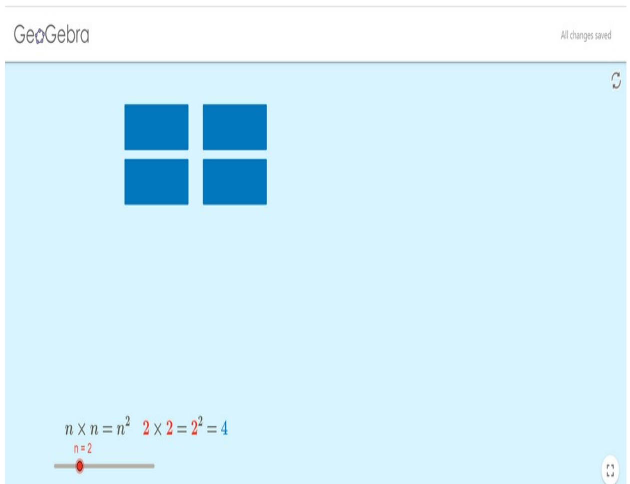
Prior to ninth grade, all students have already learned multiple fundamental concepts that involve exponents. They should already be familiar with the concept of repeated multiplication, converting from exponential notation to expanded notation and conversely, and at least the first ten perfect squares. They should have some exposure to the fundamental laws of exponents and how to simplify expressions using those rules. Some students have retained these processes better than others. Lastly, they have used Pythagorean Theorem and maybe even other instances where exponents tie with Geometry concepts. This Pre-Assessment will evaluate how much of this knowledge they have retained in those previous grade levels. The Pre-Assessment will be created on IXL, it will immediately give the students a score after they submit, and it will even categorize students based on score. The results will be useful for the planning of lessons in this unit.

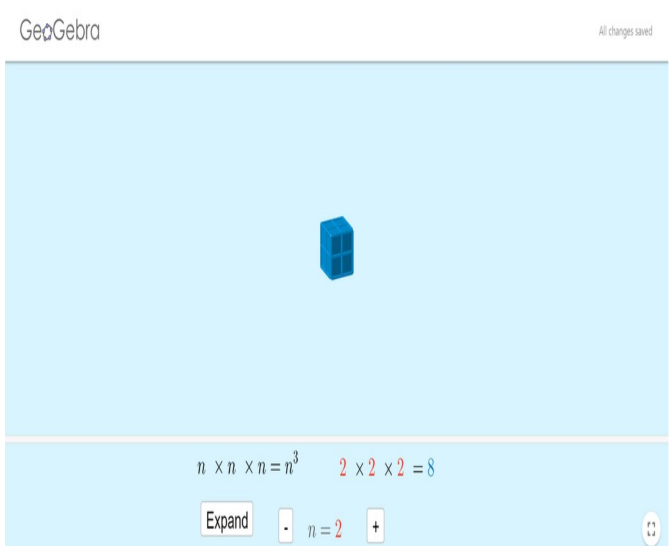
5E	Details of 5E Lesson Implementation
Engage - Initial class discussion about the Earth's core and why it is important - Show video: "NASA's Psyche Spacecraft Prepares for Trip to Asteroid by Testing Solar Arrays - Show video: NASA's Psyche Mission to an Asteroid: Official NASA Trailer	**Procedure:** To begin the unit, we will begin with a casual conversation about the Earth's core and why it is important. On the projector, I will present this question: "Why should we care about the Earth's core?" The majority of students have heard of the core, but most have minimal knowledge about its functions and why it plays a vital role in all habitation on earth. Maybe a couple will mention the core being related to our magnetic field, but I would be surprised if any students know the details. Next, I will ask the students if we have ever been to the core. The answer is an emphatic "no", but we have discovered an asteroid, 16 Psyche, in our solar system that appears to have acted as the core for a forming planet during the early stages of the formation of our Solar System many years ago. It is one of the select few asteroids that consists mostly of metals. To further explore this special asteroid, I will show two videos that talk about 16 Psyche and the Spacecraft they are building to land on this site. After the video, I will tell my students that the planning for this mission involves exponents and exponential functions. **Modifications:** No modifications needed during this stage. **Standards Addressed:** We are not addressing any standards during this stage. **Formative/Summative Assessments:** There is no type of Formative or Summative Assessment at

	this stage. **Resources** - Class projector - Google Classroom page
Explore - Students will work in groups of two and explore perfect squares and cubes with the handout. - We will elicit responses for similarities and differences between perfect squares and cubes. - The activity will be done with a manipulativ e on Geogebra.	**Procedure:** To begin our exploration of the properties for exponents, students will be given an activity sheet titled: “Exploring Perfect Squares and Cubes.” My students will stay in their usual groups of two and use their chromebooks. Each group of two will have to type in the link written on the first page of the sheet and enter the join code. Once students are in, they should see a manipulative with a square in the center and a slider at the bottom. The slider starts at zero and ends at five, and it visually shows the first give perfect squares with actual squares. I will explain the directions and model how to complete the first two perfect squares for #1. The groups will then explore the third, fourth, and fifth perfect squares and draw the visual on their sheet to complete the remainder of #1. Once students are done with #1, we will go over the first five perfect squares with the answer key. I will ask guided questions that give students the basis to identify patterns for perfect squares. For instance, some patterns student may notice are: n-squared is equal to n x n, n is made up of unit squares, and represents both the length and width of the large square.” Any type of student feedback is viable to the discussion, but moving forward, but I will guide students to look for more patterns. If you shade the unit squares on the top row, and one of the side columns, you will also notice that the unshaded squares display the previous perfect square. The next pattern you can determine is how many squares you need to add to the large square to form the succeeding perfect square. The groups will now complete problems two through six on their own. As I am circulating, I may need to model how students should show their work so that they have an idea of how they should answer. On the next page, students will enter a new link and join code to explore perfect cubes. The will use the same kind of manipulative as for the first page, and they will explore the first six perfect cubes.

They will write down the perfect cubes, as well as the repeating factors, for #1. They do not need to draw the visual model for each perfect cube because there are too many squares. Then, I will elicit student responses for #'s ten and eleven to discuss similarities and differences between perfect squares and cubes. The main takeaways are the exponents are repeated multiplication and exponents cause values to grow very quickly.

Attached below are screenshots of the GeoGebra manipulative and the activity sheet respectively:





Name: _________________________________ Date: ____________________ Block: ________

Exploring Perfect Squares & Cubes

Perfect Squares

Go to www.geogebra.org/classroom and enter code **KMKQ TDPG**.

1. Identify the first five perfect square numbers. Draw a visual representation for each.

2. The interactive shows how many squares can be put together to make a perfect square. The interactive shows that one square is a perfect square. How many squares must be added to the n=1 square to make the n=2 square?

3. How many squares must be added to the n=2 square to make the n=3 square?

4. How many squares must be added to the n=3 square to make the n=4 square?

5. How many squares must be added to the n=4 square to make the n=5 square?

6. Identify a pattern that shows how many squares must be put together to make a perfect square. Use this pattern to find how many squares there will be with n=9.

Perfect Cubes

Go to www.geogebra.org/classroom and enter code **RUSC 8D5F.**

7. What are the first five perfect cubes?

8. Recall how adding the first n odd numbers helped you find the perfect square n. Is the following true or false?

To find the perfect cube of n, add the first n odd numbers and multiply it by n since cubes are 3-dimensional.

9. Provide an example that explains your answer from #8.

Comparing

10. What are some similarities between perfect squares and cubes?

11. What are some differences between perfect squares and cubes?

Modifications:

For some students with IEP's or 504's, they will need certain tasks broken down into manageable units. Therefore, I will give students specific parts to focus on one at a time. First, students should focus on modeling the first five perfect squares using the manipulative. Then, they will move on to the other tasks.

Specific students will need a checklist that outlines what they should do in order, and then they can check off the tasks upon completion.

All of the students will need a multi-sensory approach to learning. For instance, all directions must not only be stated

	verbally, but also in writing. Certain students will need constant feedback, reinforcement, or cues for redirection throughout the activity in order to stay on task or maintain confidence. **Standards Addressed:** No standards addressed during this stage. The standard: 8.EE.A.2 involves square roots and cube roots, which will occur in the next unit. Exponents and Roots are two separate units in the Algebra 1A course that I teach. **Formative/Summative Assessments:** No Formative or Summative Assessment during this time. This is an exploration activity. **Resources:** - Perfect Squares and Cubes Exploration Activity - GeoGebra manipulative - Projector to display videos
Explain During the notetaking phase, students will be asked guided questions where they have to justify their reasoning and critique the reasoning of others. They will also have to recap what they learned during	**Procedure:** **6.1 Notes:** I will pass out 6.1 Notes to each student. Students will still be working in groups of two (as usual), but they will be filling in their own Notes. No chromebooks will be allowed during this time. We will begin with guided instruction on the first page, and fill in blanks for the following vocabulary words: exponent, base, exponential notation, expanded notation, and customary notation. I will model how to convert between the different notations for #'s 1,2,4, and 8, but I will also ask guided questions so that students are formulating the rules without me directly telling them. For #1, I will show how to convert the expression from expanded to exponential form, and they have to use the knowledge they gained from that activity to explain to me why I used those exponents. When we do #4 together, I may expand

the Explore Phase.	the expression, originally in exponential notation, the wrong way so that students can take a moment to look at my work, process the information they learned in the Explore stage, and then realize that I made a mistake. They have to not only correct my error, but they also have to justify their reasoning and critique my reasoning. Numbers 1-3 are exercises for converting from expanded notation to exponential notation. Numbers 4-6 are exercises for converting from exponential notation to expanded notation then customary notation. For numbers 7-9, they expand and write as a multiplication expression. Lastly, students will fill in the first fifteen perfect squares and the first six perfect cubes. They may not use a calculator, but they can use their multiplication table. They should be able to see the diagonal path the perfect squares form on the table. Students will peer-assess with their partner(s) once finished. As they peer-assess, they will swap packets, look at each problem step-by-step and use a pen to point out errors. An established expectation for peer-assessing is to give their partner time to identify the error themselves. If they are still struggling, the other partner can justify what is the correct process. Attached below is a blank copy of 6.1 Notes:

Name: ______________________________ Date: ______________ Block: __________

Section 6.1: Perfect Squares & Cubes

OBJECTIVE: Explore and discover perfect squares and cubes. Show in both expanded and exponential form.

An ________________________ is a number that counts the number of factors we have of another number called the ____________________.

2^5 is a number in _________________________________. 2 is the *base*, 5 is the *exponent*.

$$2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32.$$

$2 \times 2 \times 2 \times 2 \times 2$ is the number written as a ***multiplication expression.***
The answer 32 is called ***customary notation***.

We can convert between exponential notation and customary notation by performing the multiplication or counting the number of factors.

Write each expression using exponents:

1) $3 \times 3 \times 3 \times 3$ 2) $-5 \times -5 \times -5$ 3) $6 * 6 * 6 * 6 * 6 * 6 * 6$

Convert to customary notation:

4) 3^5 5) 2^3 6) 5^4

Write as a multiplication expression:

7) 2^4 8) $6^4 x^5$ 9) $9^5 y^2 z^4$

<u>Perfect Squares:</u> Whole numbers with an exponent of ________________.

Examples:

- $4^2 = 4 \cdot 4 = 16$
- $\left(\frac{3}{4}\right)^2 = \frac{3}{4} \bullet \frac{3}{4} = \frac{9}{16}$

Fill in the chart below with the most common perfect squares.

$1^2 =$	$4^2 =$	$7^2 =$	$10^2 =$	$13^2 =$
$2^2 =$	$5^2 =$	$8^2 =$	$11^2 =$	$14^2 =$

$3^2 =$	$6^2 =$	$9^2 =$	$12^2 =$	$15^2 =$

Perfect Cubes: Whole numbers with an exponent of ________________.

Examples:

- $5^3 = 5 \cdot 5 \cdot 5 = 125$
- $\left(\frac{1}{4}\right)^3 = \frac{1}{4} \bullet \frac{1}{4} \bullet \frac{1}{4} = \frac{1}{64}$

Fill in the chart below with the most common perfect cubes.

$1^3 =$	$4^3 =$
$2^3 =$	$5^3 =$
$3^3 =$	$6^3 =$

Modifications:

- Visual cues for certain students that have ADHD (as stated on their 504)
- Notes provided for students
- Break down tasks into manageable units for specific students (i.e. provide examples where they are given part of the conversion to expanded notation, and they have to fill in the remaining portion.)
- A group of four or five students working in a small group, with the in-class support, that goes at a different pace from the rest of the class.

Standards Addressed

Just like during the explore phase, there are no standards addressed during this stage. The standard: 8.EE.A.2 involves square roots and cube roots, which will occur in the next unit. Exponents and Roots are two separate units in the Algebra 1A course that I teach.

Formative/Summative Assessments:

None during this stage.

Resources:

- 6.1 Notes

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- Pencil
- Calculator (will be provided to a few students)

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Evaluate

The assessment portion of Lesson One will be an Exit Ticket on IXL. The Exit Ticket will be created by me, and I will use the new Quizzes feature.

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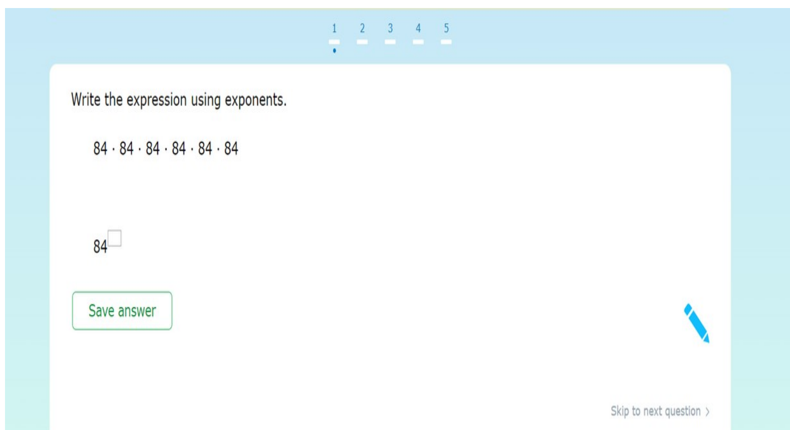
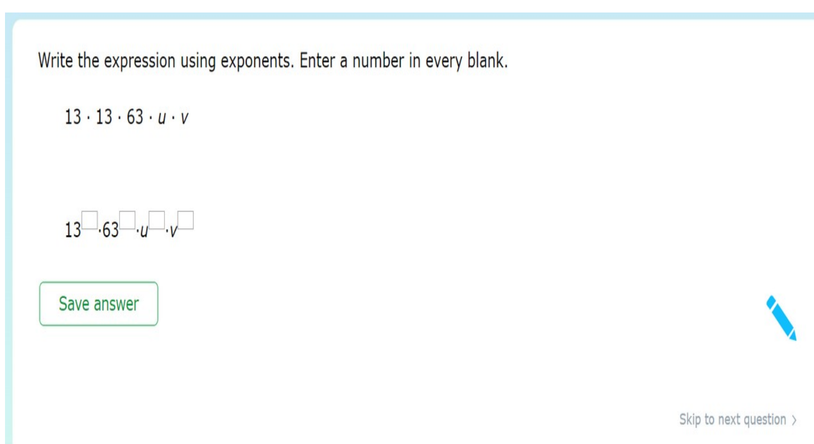
Procedure:

Formative: To check for mastery of the instructional objective, students will complete a five question exit ticket. The Exit Ticket will assess their ability to make sense of exponents, and write expressions in exponential form, and evaluating exponents (expanding and finding the product). It will be completed on IXL, and then they will all submit their responses for an immediate score. The scores will be automatically tiered on a bar graph, so this allows me to easily identify the level of mastery for each student and determine potential groupings.

Attached below are screenshots of the questions:





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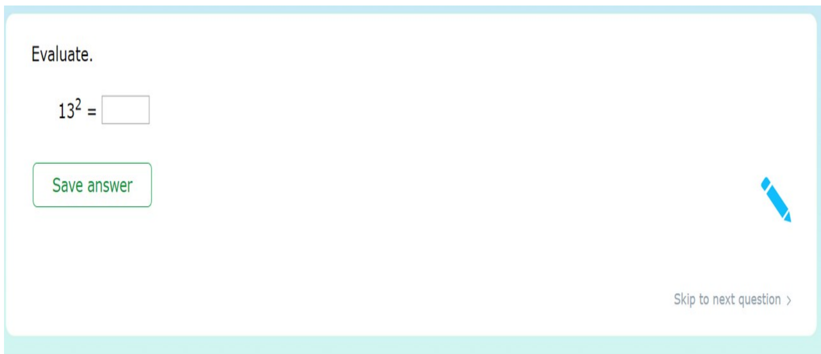
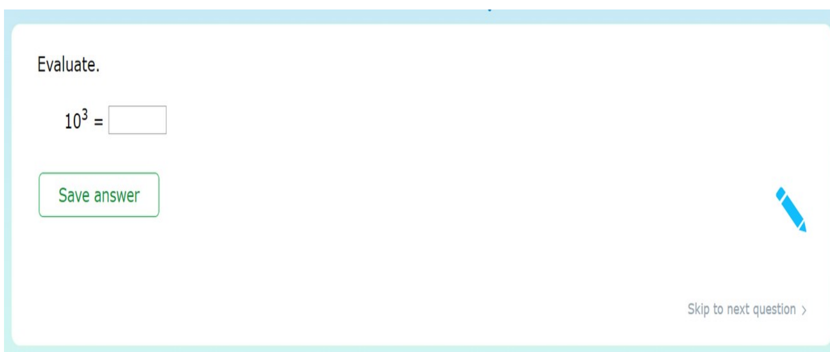




Modifications:

No modifications for this Exit Ticket.

Standards Addressed:

No standards addressed during this stage.

Formative/Summative Assessments:

Formative: 6.1 Exit Ticket

	Resources - 6.1 IXL Exit Ticket on Chromebook

Materials

- Pencil
- Eraser
- Chromebook
- Exploring Perfect Squares and Cubes handout
- 6.1 Notes
- 6.1 Exit Ticket

Lesson 2

5E's Addressed in Lesson 2: Engage, Explore, and Explain

Stages of Lesson

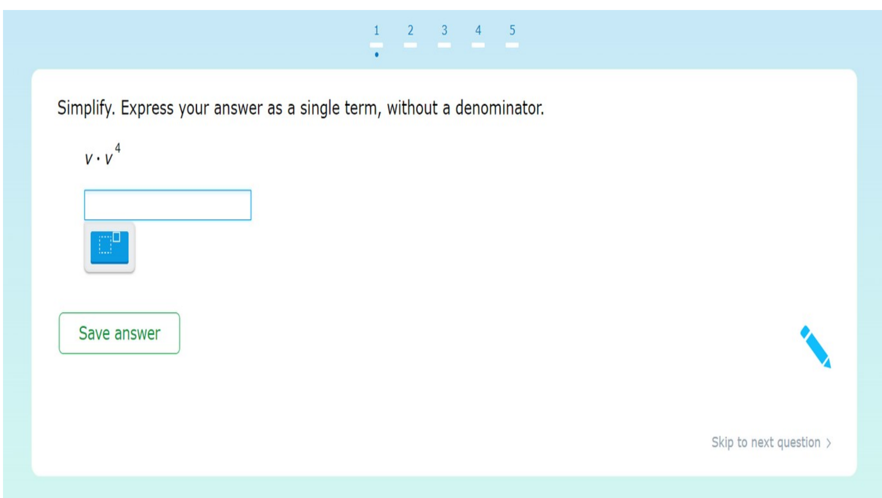
- **Instructional Outline:**
  1. 6.1 Homework Check
  2. 6.2 Laws of Exponents and Scientific Notation Exploration Activity
  3. 6.2 Notes

5E	Details of 5E Lesson Implementation
Engage During the engage phase, we will talk about different types of abbreviations and shorthand. To make the conversation more relevant to students, we will specifically	**Procedure:** To launch the lesson, we will begin with a pleasant conversation about texting abbreviations. This stage of the lesson is intended to be lax and joyful. I will send them a Poll Everywhere link, and they will submit as many texting abbreviations they will think of. The abbreviations will be displayed on the projector. We will briefly discuss the purpose of abbreviations and why we use them. This will be a great leeway to posing the following question: "How do we make 'big' numbers 'small'?" This will give an opportunity for students to not only build curiosity, but also to identify real-life examples of having to "abbreviate" very large numbers. We will have another discussion on where we would typically see very large numbers. Student responses may include national debt, compound interest, and especially space. Scientific Notation is most commonly used for various measurements in space, and we will see examples of Scientific Notation later on in the lesson.

focus on abbreviations used in texting. We will talk about the purpose of abbreviations and delve into how it connects with scientific notation. This allows students to associate scientific notation with making big things smaller.	The screenshot for the Poll Everywhere activity is attached below:  **Modifications:** No modifications needed during this stage. **Standards Addressed:** No Standards addressed during this time. **Formative/Summative Assessments:** No Formative or Summative Assessments. **Resources:** - Pencil - Projector - Poll Everywhere
Explore Instead of being shown how to perform the Law of Exponents, a better strategy would be to have	**Procedure:** For the exploration activity, each student will receive a mini-whiteboard, a marker, and an eraser. The students will be working in groups of two, but will have to display their own work on the mini-whiteboard. Since students will not be told how to perform each exponent rule, they will have to grapple with prior knowledge, compare their results with mine, communicate with their partner to identify the processes, and then surmount their cognitive conflict. It is important to note that once a student recognizes the process, he should not tell their partner. Instead, they should display their strategy for determining the result and then precisely explain the

students go through an experience where they form their own conjectures for the different laws of exponents. For this exploration activity, the bases may be numeric or algebraic. There will also be Scientific Notation expressions.	process without giving away the answer right away. There will be fifteen rounds for this activity, and it is not meant to be competitive. The reason is because I want a calm environment where students feel safe to take time processing new information. On their mini-whiteboards, students are encouraged to display their result using any model they choose. They can expand, perform integer operations for the exponents, etc. At the end of each round, I will reveal the result after all students gave an attempt on their mini-whiteboards. At specific rounds, I will elicit student responses so that we can formulate each of the exponent rules as a class. We will also draw conclusions for converting numbers into scientific notation. A link for the 6.2 Laws of Exponents and Scientific Notation Exploration Activity on Google Slides is here. **Modifications:** No modifications during this phase. **Standards Addressed** 8.EE.A.4: Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. **Formative/Summative Assessments:** No Formative or Summative Assessment **Resources:** - Mini-whiteboard, markers, erasers - Projector - Exploration Activity
Explain During the notetaking phase, we will recap	**Procedure:** To informally assess, I will assign a five question IXL quiz to all of my students, and they will be immediately scored. Their score will determine their grouping and the level of instruction provided to them. Students who received a 5/5 on the quiz, will mostly work in

everything from the exploration activity, and I will provide explicit instruction for various problems within certain groups. I will provide guided instruction for the Scientific Notation problems when necessary.	a group that independently completes 6.2 Notes and check their work with the Answer Key. I will provide some necessary instruction for this group: as well as for the rest of the groups. The students who received a 3/5 or a 4/5 will work in a group that will complete 6.2 Notes, but will be monitored by me. I will provide differentiated instruction wherever necessary by asking guided question that allow students to see the process. I may even start an IXL Group Jam so that I can first model how to do a couple of the problems, and then the group tries a couple on their own. The students who scored below a 3/5 will work in a group with the in-class support. The in-class support will provide the students with colored pencils and a handout which displays all of the exponent rules. They will color code same bases, and use a pencil to show the operation we need to perform step-by-step. Regardless of the group, I will get students together at some stage so that we can collectively explore how to convert Negative Exponents (bottom of Page Two). I may call on a couple of student to go up to the board and show their work for that portion of Page Two. As a class, we will thoughtfully form a rule for converting negative exponents. Once we get to page four, I may provide some more whole-class explicit instruction on Scientific Notation depending on the feedback I am receiving from student work. If students are comfortable with the procedures of Scientific Notation, I will differentiate my instruction to smaller groups of students. If there are still some important key concepts that students are missing as they work (such as the decimal being in the wrong place, or not knowing when the exponent is positive or negative for the base ten), I will get the whole class together. Attached below is a screenshot of the IXL Informal Assessment:



1 2 3 4 5

Simplify. Express your answer as a single term using exponents.

$679^{1} \cdot 679^{88} \cdot 679^{1}$

Save answer

Skip to next question ›

1 2 3 4 5

Simplify. Express your answer using positive exponents.

$\frac{8h^{9}}{h^{4}}$

Save answer

Skip to next question ›

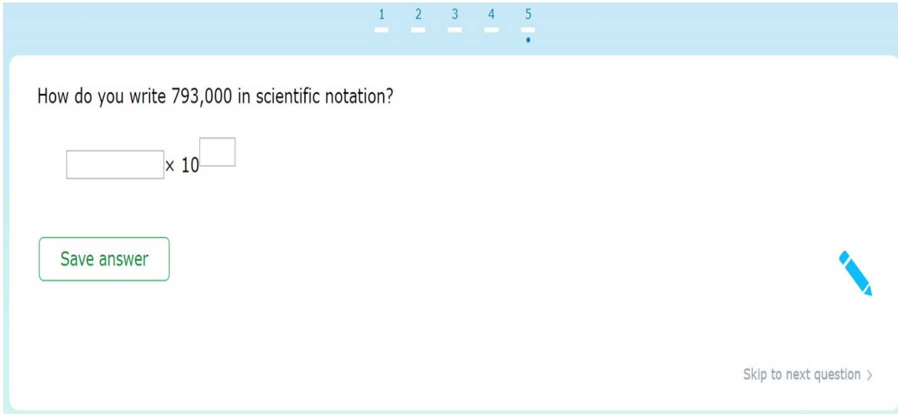
1 2 3 4 5

Evaluate. Write your answer as a fraction or whole number without exponents.

$3^{-4} =$ ☐

Save answer

Skip to next question ›



6.2 Notes –

Each student will receive the packet for 6.2 Notes after the exploration activity. Depending on how they scored on the informal assessment (IXL Quiz), they will be in a group that completes the problems in a specific way. The first page of the packet has fundamental Product Rule and Quotient Rule problems. None of the expressions on this page have more than two different variable bases. The second page continues with Quotient Rule, but also includes Zero Exponent examples and delves into Negative Exponents. The bottom of the second page has an exploration phase where students have to use Quotient Rule and expand/simplify for two different expressions. Based on their work, they have to determine how we can make a negative exponent positive. The third page provides four exercises where some of the bases have negative exponents; as well as four exercises where students are putting all of the exponent rules together. The fourth and fifth pages are strictly for Scientific Notation rules and problems. First, I want to see how the students fare with the Scientific Notation problems. I want to act more as a facilitator then an instructor. For those last problems, the difficulty levels that each group is revealing will determine how I instruct. Towards the end of the lesson, I will provide one more assessment to determine student mastery. This will be a formative assessment made on IXL, and it is considered an Exit Ticket (6.2 IXL Exit Ticket).

Attached below are the screenshots for a blank copy of 6.2 Notes:

Name: ______________________________________ Date: ____________________ Block: ______________

Section 6.2A - Laws of Exponents

OBJECTIVE: Use product, quotient, zero and negative exponent rules to simplify expressions. Apply to both numbers and variables.

Product Rule:

What happens when expressions containing exponents are multiplied?

Expand the following and then write your answer using exponential notation.

1) $2^3 \bullet 2^2 =$ 2) $3^3 \bullet 3^5 =$ 3) $7^3 \bullet 7^6 =$

The rule for exponents when two monomials **with the same base** are **multiplied**:

__________ **the BASE, ______________the COEFFICIENT & ______________ the EXPONENT**

4) $x^4 \cdot x^2$ 5) $x^4 \cdot y^2$ 6) $x^3 \bullet x^2 \bullet y^2$

7) $2^3 \bullet 2^5 \bullet 3^4 \bullet 3^7$ 8) $4^2 \bullet y^6 \bullet 4^{11} \bullet y^{15}$ 9) $3x^4y^2 \cdot 4x^2y^4$

Quotient Rule:

When expressions containing exponents are divided, once again expand them and simplify. Then write your answer in exponential notation.

1) $\frac{2^3}{2^2}$ 2) $\frac{3^5}{3^2}$ 3) $\frac{4^6}{4^4}$

The rule for exponents when two monomials **with the same base** are **__divided__**:

__________ the BASE, ______________the COEFFICIENT & _____________ the EXPONENT

Ask yourself: **"Where are there more and how many more are there?"**

4) $\frac{x^3}{x}$ 5) $\frac{x^4}{x^3}$ 6) $\frac{x^5}{y^2}$

7) $\frac{4x^3}{2x^2}$ 8) $\frac{9x^3y^5}{3x^3y^2}$ 9) $\frac{10x^3y^3}{15x^4}$

__Zero Exponents:__

Any number raised to the zero power is _______________.

1) 2^0 2) $10{,}981{,}320^0$ 3) y^0 4) x^0yz

5) x^2yz^0 6) $2x^0y^3z^0$ 7) $3y^0$ 8) $xy^7 \cdot x^0y^0$

__Negative Exponents:__

__Exploration:__
What happens when the power in the numerator of a fraction is smaller than in the denominator? For example, expand the following and then simplify using exponent notation.

Using Quotient Rule: $\frac{2^3}{2^5}$	Using Quotient Rule: $\frac{x^4}{x^7}$
Expanding & Simplifying: $\frac{2^3}{2^5}$	Expanding & Simplifying: $\frac{x^4}{x^7}$

How can we make a negative exponent positive?

__Negative Exponent Property__

Move to the opposite part of the fraction and make the exponent positive.
"Move it and Lose it"

$$x^{-a} = \frac{1}{x^a} \text{ or } \frac{1}{x^{-a}} = x^a$$

1) 2^{-2} 2) x^{-5} 3) xy^{-2} 4) $x^2 \cdot x^{-2}$ 5) $x^2 \cdot y \cdot x^{-5}$

Putting it all together!

1. Move negative exponents
2. Use product rule on numerator
3. Use product rule on denominator
4. Use Quotient rule to simplify the fraction

1) $\frac{x^2}{x^{-2}}$ 2) $\frac{xy^{-2}}{y^3}$ 3) $\frac{x^{-4}y^{-2}}{xy^5}$ 4) $\frac{x^2yz^{-1}}{x^{-3}y}$

Scientific Notation

Scientific Notation is used often in science to represent very large or very small numbers.
Negative exponents are allowed in scientific notation, they represent smaller numbers.

Examples:

1.08×10^9: Approximate speed of light is 1080 million km per hour or 1,080,000,000 km per hour

1.0×10^{14}: Approximate number of cells in the human body is 100 trillion or 100,000,000,000,000

$9.1093822 \times 10^{-31}$: Mass of an electron is 0.00000000000000000000000000000000091093822 kg

Definition of Scientific Notation	A number is expressed in scientific notation when it is in the form $$a \times 10^n$$ Where $1 \le a < 10$ and n is an integer Not all numbers with a power 10 are in scientific notation. To be in scientific notation the rules below have to be true. a: will be an integer or a decimal less than 10 and larger than 1 but not a fraction n: can be a positive or a negative integer

When we move the decimal place to the **LEFT**, we will have a **POSITIVE** exponent on the power 10.

Customary/Standard Notation	**Scientific Notation**
24,000,000,000,000	2.4×10^{13}

When we move the decimal place to the **RIGHT**, we will have a **NEGATIVE** exponent on the power 10.

Customary/Standard Notation	**Scientific Notation**
0.0000045	4.5×10^{-6}

Examples: Convert the following numbers into Scientific Notation:

When the number in front of the power 10 becomes **smaller**, to compensate we make the exponent of the power 10 ***bigger***.

1) Mass of the sun: 198.9×10^{31} grams

When the number in front of the power 10 becomes ***bigger***, to compensate we make the exponent of the power 10 **smaller**.

2) Radius of Hydrogen Atom: $0.00529177 \times 10^{-6}$

Multiplying and Dividing with power 10's by using exponent rules.

MULTIPLYING Steps:

Step 1: Multiply the numbers in front of the power 10. *(You can make adjustment to the number in front of the power 10 by changing the exponent accordingly to make it easier to multiply the numbers without a calculator)*

Step 2: Keep the 10, common base, and add the exponents. *(Negative exponents are acceptable.)*

Step 3: If the number in front of 10 is not between 1 and 10 not including 10, adjust the decimal place so the final answer is in Scientific Notation.

DIVIDING Steps:

Step 1: Divide the numbers in front of the power 10. *(You can make adjustment to the number in front of the power 10 by changing the exponent accordingly to make it easier to divide the numbers without a calculator)*

Step 2: Keep the 10, common base, and subtract the exponents. *(Negative exponents are acceptable.)*

Step 3: If the number in front of 10 is not between 1 and 10 not including 10, adjust the decimal place so the final answer is in Scientific Notation.

Examples: The following problems involve multiplying or dividing two numbers in Scientific Notation. Use the Laws of Exponents to get the answers to two significant figures.

1) Number of nuclear particles in the sun: 2.0 x 1033 grams/1.7 x 10-24 grams/particle

2) Number of stars in the visible universe: 2.0 x 1011 stars/galaxy x 8.0 x 1010 galaxies

3) Age of universe in seconds: 1.4 x 1010 years x 3.156 x 107 seconds/year

Modifications:

- Visual cues for certain students that have ADHD (as stated on their 504)
- Notes provided for students
- A group working with the in-class support and using a color-coding strategy to make the problems easier to process.

Standards Addressed:

8.EE.A.4: Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Formative/Summative Assessments:

	- Informal Assessment produced on IXL Quizzes - Formative: When there is about ten to twelve minutes left in the block, I am going to a few problems from the 6.2 Notes Packet that I did not assign earlier. I will collect each of the student packets and give them feedback for those specific questions the following class. The feedback will be written on their packets, and I will give them back to each student. **Resources:** - 6.2 Notes - 6.2 IXL Informal Assessment

Materials

- Pencil
- Eraser
- Mini-whiteboards
- Markers
- Chromebook
- Exploring Perfect Squares and Cubes handout
- 6.2 Notes
- 6.2 IXL Informal Assessment

Lesson 3

Stages of Lesson

5E's Addressed in Lesson 2: Explore and Elaborate.

This lesson may span two blocks.

Stages of Lesson

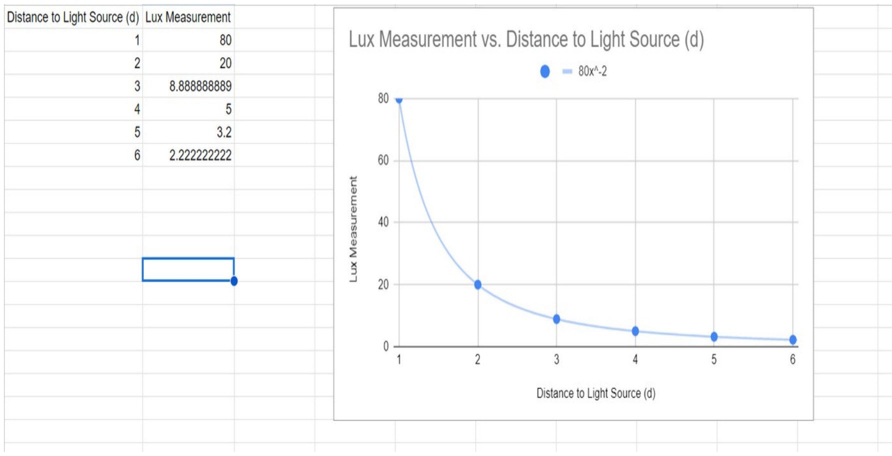
- **Instructional Outline:**
  1. 6.2 Homework Check
  2. Psyche Spacecraft Mission Activity
  3. 6.3 Exit Ticket

5E	Details of 5E Lesson Implementation

<u>Explore</u> The Psyche Spacecraft task was introduced to students at the beginning of Lesson 1 with two separate videos. Before beginning the activity, we will replay those two videos so that we can refresh our memories on the background information. The students will be placed in groups of three, and go through a mathematical modeling experience that also connects with science and technology. They will go through the five stages of Mathematical Modeling	**Procedure:** We will first replay the two videos from Lesson One. After a conversation on how this task connects with exponents, students will get into pre-determined groups of three and receive their handouts. Before officially beginning, we will review the five steps of mathematical modeling: identifying essential variables in a situation, formulating models from those variables, performing operations using those models, interpreting the results of those operations, and validating the conclusions of those results. We will begin talking about potential variables after the videos conclude so that we have an idea of what we are trying to solve. To develop an idea for the variables we are trying to solve, we will begin a hands-on simulation to initially get an idea of how solar energy is influenced by distance from the sun. To begin the activity, students will go to their groups, and rearrange the desks to form large tables. Each group will use two phones, and they will use books to hold up the phones perpendicular to the table. The phones will begin with a distance of one foot between them, so the groups will use a ruler to measure. One phone will act as the LED light sensor (obtained from the lux meter app) and the other phone will have its LED light turned on. I will turn off the lights to darken the classroom, but I will keep the projector on so that there is some visibility. Students will check the light sensor to see the lux measurement. They will record the lux in their data table for a distance of one foot. Using the lux for one foot as a baseline, students will fill in their predictions for the lux measurements for the remainder of the distances: two feet, three feet, four feet, five feet, and six feet. They will record this on the second column of the data table. Once their predictions are recorded, they will measure the lux for each of those distances. At this stage, we will determine the independent and dependent variables as class: the lux depends on the distance between the two phones (in feet). Then, they will have specific directions to go to Google Sheets, and create a curve fit for their data. They will also derive an equation for their data. The function type they will select for their data is called Power Series. At this stage, students will use the function model and equation they digitally constructed to derive other lux measurements for further distances and to answer extension questions that tap into critical thinking. Each of the groups will work together, but they all need to create their own version of the Google Sheet. Students are also expected to answer the questions with their partner, but write the responses on their own paper. Attached below is a sample for what a group's curve fit may look

to see the identify data trends, draw conclusions, and make decisions.

like.



The next part of the task is to use the knowledge we just gained to answer this question: “How can we determine the Watts per Square meter available during the mission based on the Spacecraft’s distance from the sun (AU)?” The independent and dependent variables follow the same sort of logic as the light experiment earlier in the activity. This time, students will be given that solar energy can be measured in Watts per Square Meter. To extend, we will have a brief discussion on large distances and I will guide students to be reminded of Scientific Notation. Even though this is a viable method, when we use mathematical modeling we always want to make work as simple as it can be. A better alternative to using Scientific Notation are Astronomical Units. I will directly introduce Astronomical Units and give them the Watts Per Square Meter available at Earth. They will use that information to calculate the percent of solar energy the Spacecraft receives at the 16 Psyche orbit and the Watts Per Square Meter available. This portion of the exploration requires research and application of the Inverse Square Law formula. When searching for the Astronomical Units (AU) of 16 Psyche on the internet, they will see a range of 2.5 – 3.3. However, I will guide my students to critically think about which value they should focus on using in their calculation. The AU of 3.3 would be better to use because it would be best to figure out how much energy would be needed when farthest from the sun. Lastly, students will also calculate the Watts Per Square Meter available for other planets and asteroid belts to compare and contrast. This allows them to interpret their results for the 16 Psyche mission and validate conclusions for those results.

Attached below is a blank copy for 16 Psyche Spacecraft Exploration activity:

Name:____________________

Date:____________________

Algebra 1A

16 Psyche Spacecraft Mission

Section One: Testing the Inverse Square Law

1. Each group will use two Iphones for this exploration.

2. The lux meter app will be downloaded on one phone, and the other phone will have the LED flashlight turned on (light source). The lux meter app will be used to access an LED light sensor.

3. Stand the mobile devices upright as close to vertical as you can with the light sensor (typically on the front) facing in the direction of the light source. You may need to brace both phones with books to keep them perpendicular to their surface.

4. Open the lux measurement app on the phone.

5. Place the light source mobile device one foot away from the light sensor mobile and record the lux reading.

6. Based on the one-foot reading, use the inverse square law to calculate what the light reading will be at two, three, four, five, and six feet. These will be written as your predictions in the data table.

7. Move the mobile device an additional foot away. Record the lux measurement and check to see if the measurement matches your prediction. Because there may be stray light reaching the light sensor, the measurement may not exactly match your prediction.

8. Continue recording light measurements at three, four, five and six feet from the sensor, comparing measurements to predictions.

Distance to light source (d)	$\frac{1}{d^2}$	Fraction of energy	Lux
1 foot			Measured: ______
2 feet			Predicted: _______ Measured: ______
3 feet			Predicted: _______ Measured: ______
4 feet			Predicted: _______ Measured: ______
5 feet			Predicted: _______ Measured: ______
6 feet			Predicted: _______ Measured: ______

#'s 1-2: Once you have filled in the data table, answer the following questions below:

1) What is the independent variable in this experiment? Please explain.

2) What is the dependent variable in this experiment? Please explain.

Google Sheets

a. Go to *Google Sheets*
b. Type your independent variable as a title in Cell A1.
c. Type your dependent variable as a title in Cell B1.
d. Fill in your values from your data table on the spreadsheet.
e. Select all of your values from the table but exclude the titles.
f. Select *Insert*
g. Select *Chart*
h. Click on *Setup,* then *Chart Type,* and select *Scatter.*
i. Select *Customize*
j. Click on *Series*
k. Check the box for *Trendline*
l. Under *Type,* select each type function until you have a perfect curve fit for your data.
m. Under *Label*, select *Use Equation.*

#'s 3-5: First, write the function derived from Google Sheets. Then, answer the questions that follow.

Write your function here:__________________

3) Using your function, what would be the lux measure at a distance of 10 feet? Please show your work.

4) What sort of trend do you notice when looking at the trajectory of your function? Please be detailed and include the variables in your response.

5) When planning for the 16 Psyche Spacecraft Mission, should the Solar Panels be designed to make use of an abundance of solar energy or a minimal amount? Please explain.

Section Two: Calculating Solar Power for the Mission to 16 Psyche

Spacecraft at ...	Distance (d) astronomical units	$\frac{1}{d^2}$	Fraction of energy received	Watts per square meter available
Earth	1.00			1360.8 w/m^2
Psyche (asteroid belt)				
Ceres (asteroid belt)				
Mars				
Jupiter (at farthest distance from sun)				

Modifications

- Visual cues to redirect certain students that have ADHD (as stated on their 504)

Standards Addressed

HSA-CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

HSS-ID.B.6a: Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context.

HFS-LE.A.2: Construct linear and exponential functions, including arithmetic and geometric sequences (with Power Series involved), given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Formative/Summative Assessments

No Assessments during this Stage

Resources

- Exploration Handout
- Google Sheets
- LED light IPhone
- Lux Meter App (IPhone)

Elaborate

During this stage, students will apply what they have learned in the exploration activity for three different locations in our Solar System.

Procedure:

To apply what they have learned in the Explore portion, students will calculate the Percent of Solar Energy received and the Watts Per Square Meter available at three different locations in our Solar System. The three locations are Pluto (max), Saturn, and Neptune. The AU’s will be given, and they are 49.19 AU, 9.54 AU, and 30.06 AU respectively. My students will be assessed with a paper-based Exit Ticket.

Attached below is a screenshot for the blank copy of 6.3 Exit Ticket:

Name:
Date:

Algebra 1A

6.3 Exit Ticket

Directions: Calculate the fraction of energy received and Watts per Square Meter available (1360.8 w/m^2 on Earth) at the following locations in the Solar System. Make sure you show all of your work and write your answer in a complete sentence.

1. Pluto (max) - 49.19 AU

2. Saturn - 9.54 AU

3. Neptune - 30.06 AU

	Modifications: - Visual cues to redirect certain students that have ADHD (as stated on their 504) **Standards Addressed:** No Standards addressed during this stage. **Formative/Summative Assessments:** 6.3 Exit Ticket: Students will submit their work for a grade out of 10 points. All work must be shown and their results should be clearly visible within the data table. **Resources:** - 6.3 Exit Ticket - Pencil - Calculator

Materials
- Pencil
- Eraser
- Chromebook
- Scientific Calculator
- 16-Psyche Spacecraft Mission handout
- Two phones
- 6.3 Notes
- 6.3 Exit Ticket

Lesson 4

Stages of Lesson

5E's Addressed in Lesson 4: Explore and Explain.

Stages of Lesson

- **Instructional Outline:**
  1. Google Form Do Now
  2. Venn Diagram Activity
  3. 6.3 Notes

<table>
<tr><th>5E</th><th>Details of 5E Lesson Implementation</th></tr>
<tr><td>

<u>Explore</u>

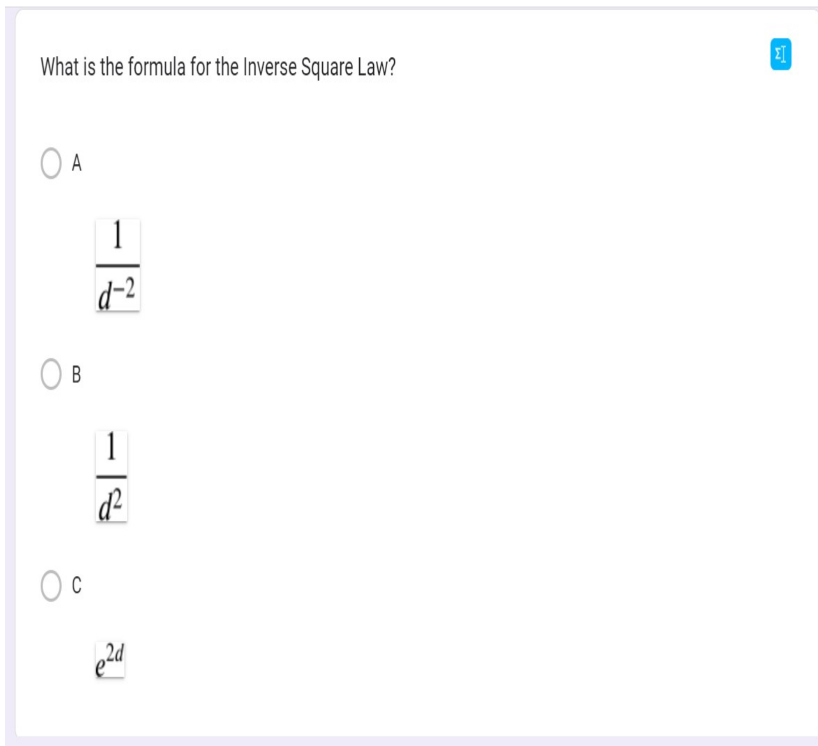
After yesterday, students gained knowledge for the multiplicative nature of exponents with the use of both a data table and a graph. For the graph, we used technology to create an example of an inverse Power Function. Today, we are going to place more of an emphasis on Exponential Functions. We will not just derive the parent function, but we will delve into the different transformations of Exponential Functions and create models for a couple real-life problems.

</td><td>

Procedure:

I will first have my students fill out a Google Form. The Google Form asks simple questions which allows students to revisit what they learned yesterday. We will briefly go over the questions as a class so that we can clarify important content.

Attached below are screenshots that show the Google Form Questions:



What is the formula for the Inverse Square Law?

A

$$\frac{1}{d^{-2}}$$

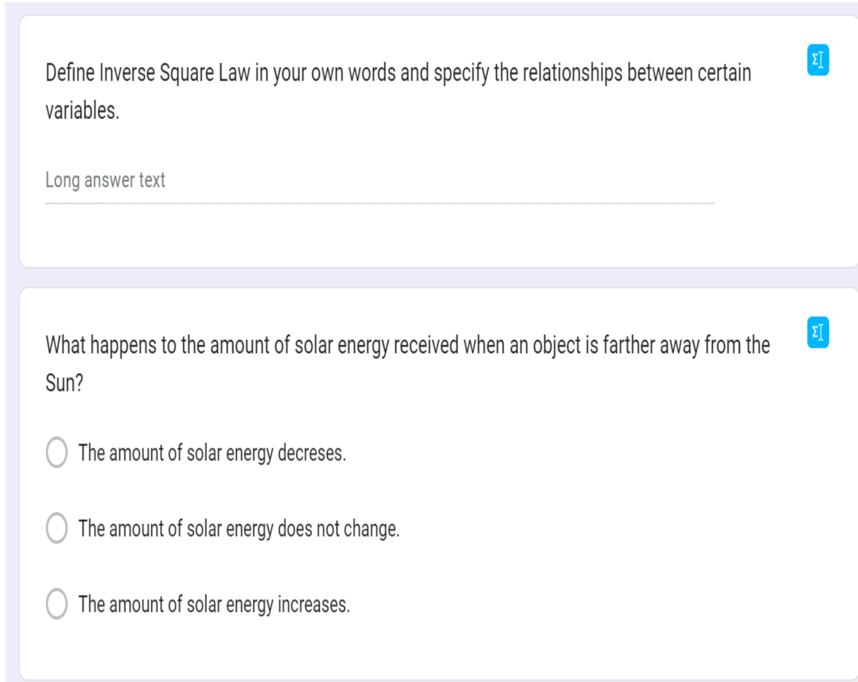
B

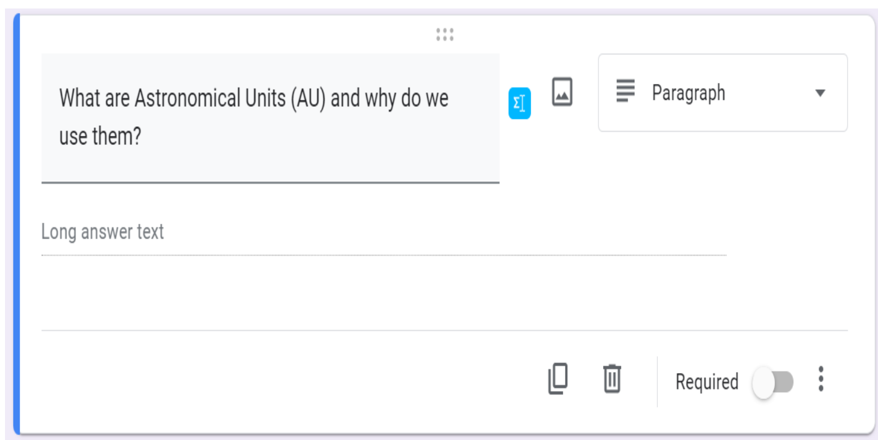
$$\frac{1}{d^{2}}$$

C

$$e^{2d}$$

</td></tr>
</table>

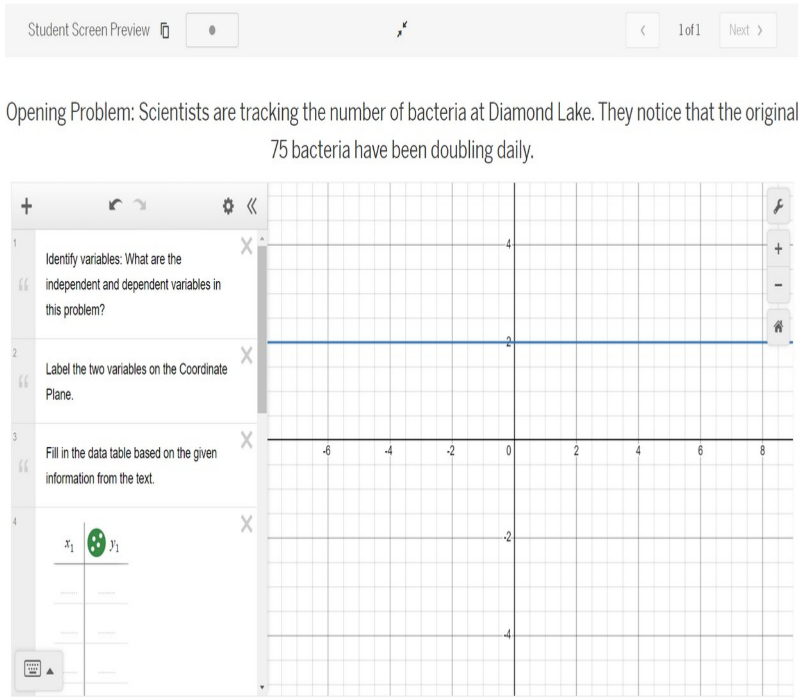


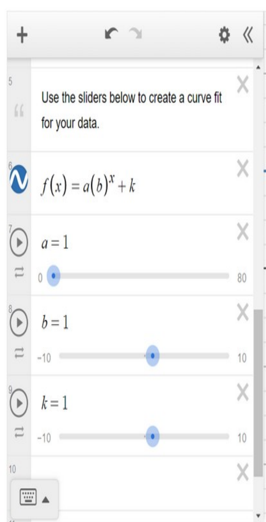


To launch the lesson, I will project a data table for a linear function, a data table from one of yesterday's groups (distance (in feet) vs lux measure) and a table which shows values for an exponential function. The two data tables will be pasted next to each other on the Google Slide. As they are being projected, I will have my students, seated in groups of two, go with their partner and claim an area on one of the classrooms three large whiteboards. They will take a marker, and draw a large three-ring Venn Diagram for more space. They will label the left ring as: "Inverse Power Function"; the right ring will be labeled as: "Exponential Function"; and the bottom ring will be: "Linear Function." The middle ring is where they will write down any

	similarities between the three functions. Students have to show mathematical work to justify what they are writing in the Venn Diagram. They can use any type of mathematical representation they choose when showing their work. They can even use Google Sheets (the same features as yesterday's activity) or the Desmos Graphing Calculator to help them with this activity. I will not set a timer for this because I do not want students to feel rushed. I want them to have the time to really dig deep and explore some of the characteristics of Exponential Functions. Once I feel that each group has enough vital information to share, I will give the groups about two minutes to gather their thoughts and think about how to present their findings. As a class, we will go around and have a gallery walk. Each group will share their findings, explain how their math connects with what they wrote inside the Venn Diagram, and draw some conclusions about exponential functions. I would not expect students to share much about the transformations of exponential functions, but there may be groups that touch on them a little bit. **Modifications:** - Visual cues to redirect certain students that have ADHD (as stated on their 504) - Break down tasks into manageable units for certain students. Some students might need guidance on how to organize their thinking for this task. This may include drawing table of values and showing the multiplicative factor for the y-values, looking for a factor from x to y for both functions, etc. **Standards Addressed:** HFS-LE.B.5: Interpret the parameters in a linear or exponential function in terms of a context. **Formative/Summative Assessments:** No Formative or Summative Assessments during this stage. **Resources:**

	- 6.3 Do Now on Google Form - Google Slides - Whiteboard - Marker - Google Sheets or Desmos Graphing Calculator (possibly)
Explain We will transition to 6.3 Notes, and there will be a comprehensive instructional period strictly on Exponential Functions. There will be opening problems where students will use the Desmos Graphing Calculator to construct a model for the scientific scenario, but there will be more guided instruction after this stage.	**Procedure:** Once all students are seated, I will pass out 6.3 Notes to each student. I will have a student read the opening problem at the top of the first page, and that includes the detailed directions for the problem. Once again, we will go over the five stages of mathematical modeling, the criteria for drawing a model, and go over literacy strategies to break down the text. The most common literacy strategy we use to break down a text is the CUBES Method. I will give kids a few minutes to gather their thoughts, construct a model for the situation, use the Desmos link to construct a data table, and use the sliders to construct a model for the given scenario. The sliders a, b, and k represent the components for the functions. After students have created a function that fits their data, they will write down the function at the bottom of the first page. Attached below is a screenshot of the Desmos task on 6.3 Notes:





Once all the groups of two are finished with the task, we will go to the second page of the Notes. I will introduce the parent function and then we will write down the components as a class. I will call on different students to describe what they noticed for a, b, and k as they moved the sliders on the Desmos Activity. We will fill in those components at the top of the second page. Next, there will be an instructional period on Exponential Growth vs. Exponential Decay. For problem one, I will model how to determine the y-intercept, the multiplying factor, and if the graph will show growth or decay. We will do problem two together as a class (guided questions), and students will try problems three and four on their own. We will go over the problems with the answer key. On the next page, I will use the same form of explicit instruction for the exercises on page four. This time, we will determine the y-intercept, the multiplying factor and if the graph will be growth or decay from a table of values. The class will then graph the table on the coordinate plane and write the exponential function. The last two problem on the packet are both word problem. I strongly suggest that my students use Cubes Method to identify the variable, locate the values, and eliminate unnecessary text. However, they are open to solving the problems their own way. Once finished, I will call on two students to go up to the board and display their work for each of the word problems. As an extension, problem twelve is a more complex NASA problem where students have to solve for the multiplicative factor. I may assign this to my upper level students or have this be an opening challenge problem next class. It depends on how much time is left in the block and how my students are faring with the material.

Attached below is a screenshot for a blank copy of 6.3 Notes:

Section 6.3: Exponential Functions

OBJECTIVE: Analyze graphs, tables and word problems involving exponential functions. Graph basic exponential functions from the equation and from a table.

Opening Problem

Scientists are tracking the number of bacteria at Diamond Lake. They notice that the original 75 bacteria have been doubling daily.

Create a function to represent this scenario.

Draw a model for this scenario in the table below:

Next, use this Desmos link to help you build your function: https://student.desmos.com/join/7nryhb

Write our function here: $f(x)$ =____________________

Exponential Functions

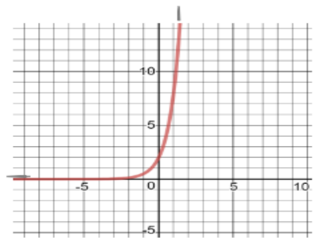
$$f(x) = a \cdot b^x$$

Where the a is representing the ______________________________________
and b is the factor the each y-value is ________________________ by.

Exponential Growth

$b > 1$

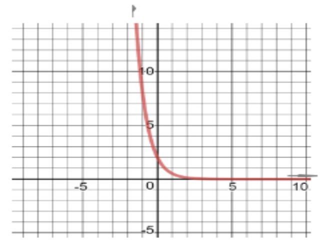
Increases from left to right



Exponential Decay

$0 < b < 1$

Decreasing from left to right



Determine the y-intercept, the multiplying factor and if the graph will be a growth/increasing or a decay/decreasing from the equations.

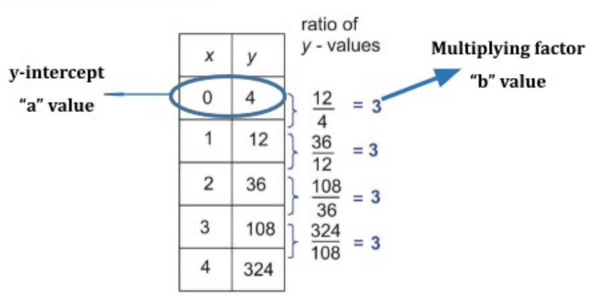
1. $f(x) = 3(5)^x$

2. $f(x) = 9\left(\frac{2}{3}\right)^x$

3. $f(x) = (0.5)^x$

4. $f(x) = \frac{1}{4}(4)^x$

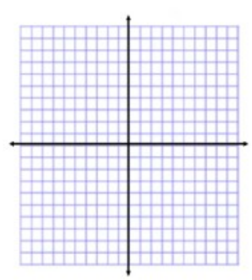
Finding Information from a Table



Determine the y-intercept, the multiplying factor and if the graph will be a growth/increasing or a decay/decreasing from the equations. Then graph the table on the coordinate plane and write the function.

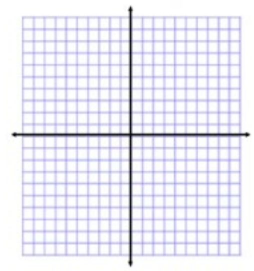
5.

x	y
-1	$\frac{2}{3}$
0	2
1	6
2	18
3	54



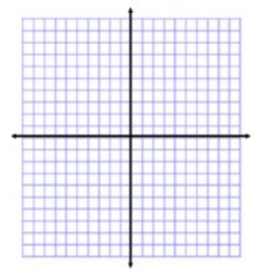
6.

x	y
-1	54
0	9
1	$\frac{3}{2}$
2	$\frac{1}{4}$



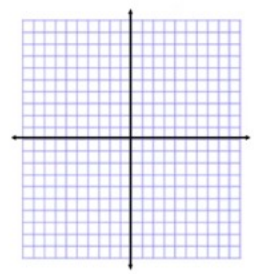
7.

x	y
-1	8
0	4
1	2
2	1
3	$\frac{1}{2}$



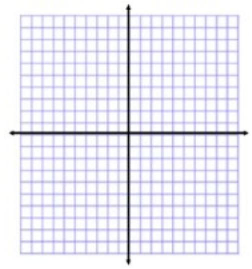
8.

x	y
-3	$\frac{1}{3}$
-2	1
-1	3
0	9
1	27



9.

x	y
-1	5
0	1
1	$\frac{1}{5}$
2	$\frac{1}{25}$



#'s 10-11: Finding Information from a Scenario

Step 1: Look for a starting amount (a-value)
Step 2: Find the multiplying amount (b-value)
Step 3: Write the function

10. Johnny currently has $500 in his bank account. Every month this amount doubles.

11. The mice population in Scranton, PA is tripling every week. This week there were 60 mice living in the town.

 # 12: Extension

12. A scientist began his career with a salary of $40,000 in 1980, and by 2000 this had grown to $100,000.

A) What was his annual salary gain each year?

B) If the annual inflation rate was 3% why do you think that his salary gain was faster than inflation during this time?

Modifications:

- Visual cues to redirect certain students that have ADHD (as stated on their 504)
- Break down tasks into manageable units for students. Practicing with one representation at a time and have specific problems to work on in chronological order.
- Notes provided to students

Standards Addressed:

HSN.SSE.B.3c: Use the properties of exponents to transform

	expressions for exponential functions. For example the expression 1.15t can be rewritten as (1.151/12)12t ≈1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%. HSA-CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. HSF-IF.C.7e: Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. HSF-IF.C.8b: Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay. HSF-BF.B.3: Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. HSF-LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions. HSS-ID.B.6a: Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. HFS-LE.A.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). HFS-LE.B.5: Interpret the parameters in a linear or exponential function in terms of a context.

	Formative/Summative Assessments: There will be no Formative or Summative Assessments during this stage. There will be informal assessments throughout while working on 6.3 Notes. My students will be assigned problems to individually complete, and I will check their work and provide individualized feedback. **Resources/Materials:** - 6.3 Notes - Desmos Graphing Calculator - Pencil

Materials

- Pencil
- Eraser
- Whiteboards
- Chromebook
- 6.3 Notes
- 6.1 Exit Ticket

Summative Assessment

5E	Details of 5E Lesson Implementation
Evaluate Instead of a traditional Summative Assessment to end the unit, a more effective way to see if students	**Procedure:** Once my students receive the assessment, they can begin. They will have the entire block to complete the assessment. If students need more time, they can be assigned a fixed amount of time for the next block. Each student will be independently working on their own assessment. **Modifications:**

mastered all of the objectives in the unit are to have them complete a more complex End of Unit Assessment. This assessment may have less problems then a traditional test, but it may take longer to complete because each question requires students to show conceptual understanding, critical thinking and problem-solving. It does not just assess on computational ability. Some of the questions are open-ended, there are open-middle problems, and the last question requires students to apply their knowledge of exponential functions to a real-world context.	- Some students will complete the assessment with the guidance of the in-class support outside the classroom. - Scientific calculators provided for student if stated in their IEP **Standards Addressed:** HSF-BF.B.3: Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. HSF-LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions. HSS-ID.B.6a: Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. HFS-LE.A.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). HFS-LE.B.5: Interpret the parameters in a linear or exponential function in terms of **Summative Assessments:** Screenshots for the Unit 6 Summative Assessment are attached below:

Name:
Date:

Algebra 1A

Unit 6 Summative Assessment

Directions: Answer each question below as best you can. Make sure all work is shown and legible.

Perfect Squares and Cubes

List the first 15 perfect squares.

$1^2 =$	$4^2 =$	$7^2 =$	$10^2 =$	$13^2 =$
$2^2 =$	$5^2 =$	$8^2 =$	$11^2 =$	$14^2 =$
$3^2 =$	$6^2 =$	$9^2 =$	$12^2 =$	$15^2 =$

List the first 6 perfect cubes.

$1^3 =$	$4^3 =$
$2^3 =$	$5^3 =$
$3^3 =$	$6^3 =$

Exponents

Write the following as a multiplication expression.

$3^7 =$

$(-2)^3x^5 =$

Write the following in Exponential Form.

$7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 =$

$\frac{x \cdot x \cdot x \cdot x \cdot x}{z \cdot z \cdot z \cdot z} =$

Laws of Exponents

$4^3 \bullet 4^4 \bullet 4^5 =$

$\frac{-12q^{16}}{6q^8} =$

Scientific Notation
Convert the following numbers from Standard Notation to Scientific Notation.

$0.0000000619 =$

$9,230,000,000 =$

$75,000,000 =$

$0.901 =$

Multiple Representations - Functions

1a. One of these tables represents a linear relationship, one represents an exponential growth and one represents an exponential decay. Label each table correctly.

x	y
1	6
2	9
3	12
4	15

x	y
1	56
2	28
3	14
4	7

x	y
1	6
2	9
3	13.5
4	20.5

______________ ______________ ______________

1b. Sketch graphs showing each of these relationships.

1c. Write an equation representing the exponential decay relationship.

____

Menu Task

Exponential functions:

Build as few exponential functions as possible to satisfy each constraint at least once.

A.	A negative zero	B.	Has a positive y-intercept
C.	Has no zero	D.	Never passes through quadrant III
E.	Is always increasing	F.	Never passes through quadrant I
G.	Passes through the point (2 , -3)	H.	Base value greater than 1

Which constraints match best?
Which constraints cannot be matched?
Is it possible to solve in 2, 3 or 4 exponential functions?

Describe how and why you constructed each exponential function.
Don't forget to identify which exponential functions satisfy which constraints.

Open Middle Problems

Directions: Using the integers -8 to 8 at most one time each, place an integer in each box to make the greatest possible value.

$$\square^{\square} =$$

Directions: Using the numbers -9 to 9 at most one time each, fill in the boxes to make a negative product.

$$\square^{\square} \cdot \square^{\square} =$$

Modeling

Directions: Read the problem below and each of the questions. Make sure all work is shown and you answer in complete sentences.

A bacterial population y after x days can be represented by an exponential function whose graph passes through (0, 100) and (1, 200).

(a) Draw a model that represents this scenario. Make sure you label.

(b)Write a function that represents the population.

____

(c) Find the population after 6 days.

(d) Does this bacterial population grow faster than the bacterial population in Example 7? Explain.

	Resources: - Unit 6 Summative Assessment

APA Sources

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