KUD Statement: Students will **know** exponent vocabulary. Students will **understand** that exponents are important because exponents are used in many scientific calculations, statistical calculations, and physics, to name a few. Students will be able to **do** exponential calculations.

Lesson 1	
Grade: 9th	**Subject: Algebra**
Materials: worksheets, colored cards, cards for game, markers for drawing	**Technology Needed: calculator and smart phone**
Instructional Strategies: ☐ Direct instruction (highlighted) ☐ Guided practice (highlighted) ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☐ Technology integration ☐ Other (list) ☐ Peer teaching/collaboration/cooperative learning (highlighted) ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☐ Modeling (highlighted)	**Guided Practices and Concrete Application:** ☐ Large group activity ☐ Independent activity (highlighted) ☐ Pairing/collaboration (highlighted) ☐ Simulations/Scenarios ☐ Other (list) Explain: ☐ Hands-on ☐ Technology integration ☐ Imitation/Repeat/Mimic

Standard(s)
HS.N-RN.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.
 	
Objective(s)
The student will be able to identify the base and exponent.
The student will be able to define and create his/her own expression containing exponents.
 	
Bloom's Taxonomy Cognitive Level: knowledge, synthesis
	Differentiation
	  Below Proficiency: I can modify the worksheet and give filled out notes.
	
	  Above Proficiency: Challenge these students to teach others, and do not give as many hints with the creation problem.
	
	  Approaching/Emerging Proficiency: The lesson is mostly designed for them. I can scaffold my hints and challenge these students to ask peers questions.
	
	**Provide KhanAcademy videos for students that would like a reference or additional support.
	
	https://www.khanacademy.org/math/pre-algebra/pre-algebra-exponents-radicals/pre-algebra-exponents/v/exponents-warmup
	
	Modalities/Learning Preferences: visual, kinesthetic, social

Classroom Management- (grouping(s), movement/transitions, etc.) While greeting the students as they come into class, I will hand them a colored slip of paper that will align with a spot or pod of desks in the room. This will easily group students for their learning stations. When trying to gather the class back to me, I will use my attention getting strategy of placing my finger on my nose (like nose goes) and the rest of the students should mirror me and place their finger on their nose and get their eyes on me. (We can use any method similar to this that I would let each class decide.)	**Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)** Students should be able to work well in groups. I expect students to be respectful and helpful towards each other.

I will have a turn in tray or envelope at each station, so the students can put whatever it is they worked on at that station directly into the envelope so they do not drag it around the entire classroom or get distracted by it. Additionally, by each station I will have a number hung up on the wall that correlates to the directions I used on the board.	

Minutes	Procedures
60?	**Set-up/Prep:** Prepare the learning stations and notes for the lesson. Also cut the color sheets and place them around the room. Prepare the cards that will be used in the exponent card game.
7	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** Greet Students at the door handing them their specific color. Bell ringer: If I were to ask you to multiply 5 times itself 20 times, how would you write this? I will give you a couple minutes to come up with a creative way to do so without actually writing out five times itself 20 times. (After a couple of minutes)- Now I want you to turn to your partner and share with each other what you created. Also, you and your partner, discuss why a system or method to write this would be important in the real world. After sharing, we will discuss as a class the different methods we came up with and where this could be used.
13	**Explain: (concepts, procedures, vocabulary, etc.)** Here is where I will introduce the correct method of writing these numbers down. I will explain to them what the exponent is and represents, establish the vocabulary of base and power/exponent, and explain the special cases of when the exponent is 0 or 1. Additionally, we will cover the terminology and how to say things. For example, when a number is raised to the 2 or 3, it can be said squared and cubed, respectively. Also, one says 15^5 is read as fifteen to the fifth or fifteen raised to the 5th (power). Then, I will demonstrate some examples of exponent problems. I will also show the students how to use their calculators to calculate an exponential problem. $12^3 = 12 \cdot 12 \cdot 12 = 1728$ **(here the base is 12 and the exponent is 3 and 12x12x12=1728 is known as expanded form)** **(-2)^3= -2x-2x-2= -8** $10002452420^0 = 1$ (base is 10002452420, exponent is 0) $0^0 = 0$ (this is a special case and the only time when the exponent is 0 the answer isn't one, when base is 0.) $8^1 = 8$ (base 8, exponent 1)
5- to explain stations 20- 5 min at each station **Total = 25**	**Explore: (independent, concreate practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** This is where we will have the group learning centers. I will set up 4 areas around the classroom. Each area will have a color that will coordinate with the ones given at the beginning of class. At one station, the group will create a situation where exponents would be needed. (ex: to describe the distance to the moon, to describe how small a bacterium is, the amount of ways someone could arrange a 4-letter word (word meaning 4 letters side by side, does not have to be an actual word and letters can repeat) out of 8 letters) As I monitor this group, I may give hints or provide an example if they are stuck. Additionally, if they cannot think of anything I will allow the students to use their smart phones to search for a problem/situation that exponents would be used in. The second station would have a worksheet that will be completed individually. But, I will encourage students if they are stuck to ask their peers for help. The third station will consist of a type of card game like war (thus, the game would be played in pairs) . I would have multiple "cards" with exponential expressions on them. The students would divide the cards equally and flip one at a time and then have to determine which value is bigger. The student with the greater value wins the round and collects both cards. Then, the student with the most cards or

	plays the opponent out of cards wins. The fourth station will have another worksheet that is different from the others. This is my "warm-up" worksheet.
10	**Review (wrap up and transition to next activity):** I will have the students stay at the last station they are at, and ask each group to explain the problem they created. If a group did not create a situation or come up with anything, then I will ask what was the most challenging part about it? Wrap-up: After they share their problems/difficulties, I will ask what each station had in common, add some other out of the classroom examples, and synthesize and possible talk about problems with the worksheets. Then, I will tell them that we will learn how to multiply and/or divide exponents with the same base. Also, if you did not finish your worksheet with the group, you are to complete it and turn it into me tomorrow at the beginning of class. Lastly, have students hand in assignments into different folders that are labeled "totally understand," "somewhat have a grasp of what is going on," and "eh, I do not feel good about this."

Formative Assessment: (linked to objectives)
My formative assessment will be my purposeful proximity, where I will listen to conversation. The hand in folders will also give me a way to assess where the class is at and who needs more assistance. MAKE NOTE OF WHAT I OBSERVED OR WHO WAS STRUGGLING
  Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc.
I would be monitoring each groups' progression and would ask the students to clarify what is to be done at each station before it begins.

  Consideration for Back-up Plan:
Having the winners and losers of the card game play each other if they are done too quickly.

Assist or provide hints for the station with the creation question.
Allow students to use phone if they have been trying for 3 minutes and have not come up with anything.

Give examples of drawings or sketches of exponential expressions.

If groups don't work out to be four groups of four it can easily be manipulated for the card game to work, as one can play it with 3 or more, the game will just go faster.

Summative Assessment (linked back to objectives)
  End of lesson: I will be able to collect each groups' worksheets, situation they created, and the pictures they drew that represented exponents. The individual worksheets will display how well the students are doing with the new content.

  If applicable- overall unit, chapter, concept, etc.:
The material covered today will be on the first quiz.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
I need to structure my review at the beginning in a more organized manner. Possibly create a PowerPoint with the Bell Ringer and the directions for the stations, this way it is only a click a way instead of me writing it on the board. Lastly, I need to create either colors or big numbers to hang on the wall to signify where each station is. Lastly, have students hand in the "warm up" worksheet using the categories "totally got this," "pretty good understanding," and "eh, not so good."

Lesson 2

Grade: 9th	Subject: Algebra 1
Materials: everyday classroom essentials, smartboard, notebooks, textbook, etc.	Technology Needed: projector/smartboard to watch video

Instructional Strategies:	Guided Practices and Concrete Application:
☑ Direct instruction ☑ Peer teaching/collaboration/cooperative learning ☐ Guided practice ☐ Visuals/Graphic organizers ☐ Socratic Seminar ☐ PBL ☐ Learning Centers ☐ Discussion/Debate ☐ Lecture ☑ Modeling ☐ Technology integration ☐ Other (list)	☐ Large group activity ☐ Hands-on ☑ Independent activity ☐ Technology integration ☑ Pairing/collaboration ☑ Imitation/Repeat/Mimic ☐ Simulations/Scenarios ☐ Other (list) Explain:

Standard(s)	Differentiation
HS.N-RN.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 exponent	**Below Proficiency:** These students could be given the rules of the exponents, and could be given guided notes. **Above Proficiency:** I could challenge these students by assigning couple different, more challenging problems on the assignment. **Approaching/Emerging Proficiency:** These students will be challenged by the homework as it will be in their zone of proximal development **Modalities/Learning Preferences:** social, audio, and visual Provide KhanAcademy Video for any additional support or reinforcement https://www.khanacademy.org/math/pre-algebra/pre-algebra-exponents-radicals/pre-algebra-exponents/v/exponents-warmup

| **Objective(s)** The students will be able to apply the definition of exponents to multiply and divide numbers with exponents. **Bloom's Taxonomy Cognitive Level:** application | |

| Classroom Management- (grouping(s), movement/transitions, etc.) Nose goes or attention getting device to get the students back to me after partner work. Rules on how and where students can be when working on homework. | Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.) Students should be respectful to their partners and efficiently work on the assignment. |

Minutes	Procedures
5	**Set-up/Prep:** get the exponent video ready to show
5	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** Opening Activity: fun video that reviews exponents (https://www.youtube.com/watch?v=5w5zPSEwvqw)
15	**Explain: (concepts, procedures, vocabulary, etc.)** Here, I will briefly remind the class of what a base and exponent is. Then, I will present a couple of problems involving multiplication of numbers with exponents. I will approach these by writing them in exponent form like:

$5^3 \cdot 5^4 = (5 \cdot 5 \cdot 5) \cdot (5 \cdot 5 \cdot 5 \cdot 5) = 5^7$. I will approach the next couple problems in the same way:

$7^2 \cdot 7^3 = 7^5$ and $3^3 \cdot 3^3 = 3^6$. Then, I will present this problem: $2^3 \cdot 3^2 = (2 \cdot 2 \cdot 2) \cdot (3 \cdot 3)$. I will ask the students if this can be simplified. The answer will be no, so then I will ask the students to turn to their partner and develop a rule for multiplying exponents. After they discuss, I will ask a couple groups to share to see if we came up with the same rules and possibly discuss the practicality of multiplying exponents. Then we will move on to division of two numbers with exponents. I will use the same method as multiplication by representing the

problem as: $2^3 \div 2^2 = \dfrac{(2 \cdot 2 \cdot 2)}{(2 \cdot 2)} = 2^1 = 2$. Similarly, we will do $4^6 \div 4^2 = 4^4$ and

$6^7 \div 6^2 = 6^5$. Then, I will present something a little different. I will present this problem

$9^3 \div 9^5 = \dfrac{9 \cdot 9 \cdot 9}{9 \cdot 9 \cdot 9 \cdot 9 \cdot 9} = \dfrac{1}{9 \cdot 9} = \dfrac{1}{9^2} = 9^{-2}$. Here is where I think students will begin to see why we use

negative exponents, and they will see why it simplifies to what it does. Then, I will present a problem with

different bases and show: $6^3 \div 5^2 = \dfrac{6 \cdot 6 \cdot 6}{5 \cdot 5}$ cannot be simplified. Again, I will ask the students to create a rule

for the division of exponential numbers and try to find a scenario where this occurs outside the classroom.

10 15	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** This will be the partner work of coming up with a rule for multiplying and dividing exponents. (the collective time) This will give them time to work on the assignment from the book.
5	**Review (wrap up and transition to next activity):** I will wrap up the class by discussing where we can see the application of this in the real world relating it back to examples that were created yesterday. I will foreshadow that we are covering powers to a power tomorrow.

Formative Assessment: (linked to objectives)	Summative Assessment (linked back to objectives)
Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc. I will be able to listen to their partner discussions when creating rules for the exponent rules. I will ask why we can simplify the division problems (looking for the answer of 2/2 is one and there is 2 of them which leaves us with one 2 left) When students create the rules of exponents, remind or ask them to clarify if the base needs to be the same. **Consideration for Back-up Plan:** If the lecture goes faster than expected, then as a class, we can try and find scenarios where this will be useful outside the classroom.	**End of lesson:** This will be the small book assignment that I will allow them to start on in class that will make the students use the rules of multiplying and dividing exponential expressions. This assignment will be collected at the beginning of class the next day after any major questions are answered. **If applicable- overall unit, chapter, concept, etc.:** This information will be on the quiz.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
Did partner discussion lead to the exponent rule? Did the students benefit by synthesizing their own rule? Did it lead to a better understanding? Did students work on the assignment when given the time to?

Quiz 1 Lesson Plan

Grade: 9	Subject: Algebra I
Materials: everyday classroom essentials	Technology Needed: computer/tablet/smart device that can be used for research

Instructional Strategies:	Guided Practices and Concrete Application:
- Direct instruction - Guided practice - Socratic Seminar - Learning Centers - Lecture - Technology integration - Other (list) ☐ **Peer teaching/collaboration/ cooperative learning** - Visuals/Graphic organizers - PBL - Discussion/Debate - Modeling	☐ Large group activity ☐ Hands-on ☐ **Independent activity** ☐ Technology integration ☐ **Pairing/collaboration** ☐ Imitation/Repeat/Mimic ☐ Simulations/Scenarios ☐ Other (list) Explain:

Standard(s)	Differentiation
HS.N-RN.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.	**Below Proficiency:** These students will be partnered with someone they are comfortable with that is above proficiency. Also, I will be monitoring these students during the quiz to be sure to give needed support when necessary. Furthermore, instead of an exit slip, I will give these students an entrance slip that meets standards but is not as challenging as the above proficiency slips for tomorrow.
Objective(s) The students will apply the information learned from Lesson 1 and Lesson 2 to the quiz given today. **Bloom's Taxonomy Cognitive Level:** applying knowledge	**Above Proficiency:** I will encourage these students to help tutor and review with the less proficient students. In addition, after the quiz I will challenge these students to complete an exit slip that I created that is more challenging than some of the other slips. **Approaching/Emerging Proficiency:** These students will complete an exit or entrance slip depending on when they finish their quiz. I may challenge these students with the more difficult entrance/exit slip. **Modalities/Learning Preferences:** intrapersonal and interpersonal

Classroom Management- (grouping(s), movement/transitions, etc.)	Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)
I will assign students partners using the clock idea (i.e. students write people in the class they are comfortable working with at the different numbers on the clock, then I tell them to work with a certain number). These partners will then review together. I will use purposeful proximity to ensure students are staying on track. Additionally, I will have a timer projected on the board for when the quiz will be handed out, so students are able to see when they should start rapping up and when it is time to put things away for the quiz. I will have the students raise their hand when	I will expect students to use their review time wisely to prepare for the quiz.

<table>
<tr><td colspan="2"><mark>they are finished with the quiz and hand out the exit/entrance slip.</mark></td><td></td></tr>
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Minutes	Procedures
5	**Set-up/Prep:** Print out quiz
5	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** Bell ringer: I will post on the board, "what are the 3 most important things about exponents you have learned thus far." Students will answer this question, and then they will share with the person sitting closest to them. Then, we will share a couple of groups' answers.
10	**Explain: (concepts, procedures, vocabulary, etc.)** Students will be given this time to review notes, homework, or any resource I have given them to prepare them for the quiz.
25-35	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** Students will take their quiz at this time. If they finish early they will be asked to complete an exit slip. If they take the entire time, then those students will have an entrance slip for the next day. Furthermore, I will have different entrance/exit slips that will be more challenging or right at standards to help differentiate.
0-5	**Review (wrap up and transition to next activity):** If time allows I will explain the exit/entrance slip and tell them to have a great day.

Formative Assessment: (linked to objectives)	Summative Assessment (linked back to objectives)
Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc. I will monitor reviewing and walk around seeing how the quiz is going. **Consideration for Back-up Plan:** entrance/exit slips and if all finish early then we can go over the quiz and see what problems they struggled with and go over them in class.	**End of lesson:** The quiz is my summative assessment. **If applicable- overall unit, chapter, concept, etc.:** These concepts will be on the test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
Did majority of students finish the quiz very early? Do I need to plan more than entrance and exit slips? How did review go? Should I give more or less time for review?

Connor Doll   Unit Plan- Exponents

<div align="center">Exponents Quiz 1</div>

Directions: Please identify the base and exponent in the following problems.

1. 423^{21} 2. 6^{7}

Base: __**423**__   Base: __**6**__

Exponent: __**21**__   Exponent: __7__

Directions: Please write the following problems in expanded form. You do not need to solve.

3. 7^{4} 4. 12^{6}

7x7x7x7   **12x12x12x12x12x12**

5. $4^{6} \cdot 4^{3}$ 6. $\dfrac{2^{4}}{2^{2}}$

4x4x4x4x4x4x4x4x4 $\dfrac{2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2}$

Directions: Please solve the given expression.

7. $\dfrac{2^{4} \cdot 2^{2}}{2^{8}} =$ 8. $100221^{0} =$

$\dfrac{2^{4} \cdot 2^{2}}{2^{8}} = \dfrac{2^{6}}{2^{8}} = 2^{-2} \, or \, \dfrac{1}{2^{2}}$ **1**

9. $\dfrac{5^6}{5^2} =$

5^4

10. $(7^2)^3 =$

7^6

11. $(-11)^4 =$

14,641
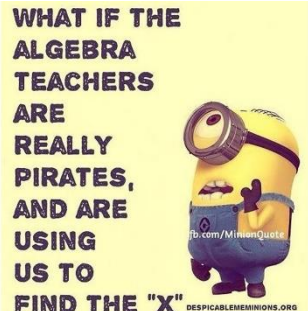
12. $(-3)^3 =$

-27

13. A window washer is assigned to wash 5 rows of windows. Each row contains 5 windows. He is to wash these windows 5 times a month. How many windows does the window washer wash in a month. (i.e. $4^3 = 64$ should be the form of your final answer). Please show all your work.

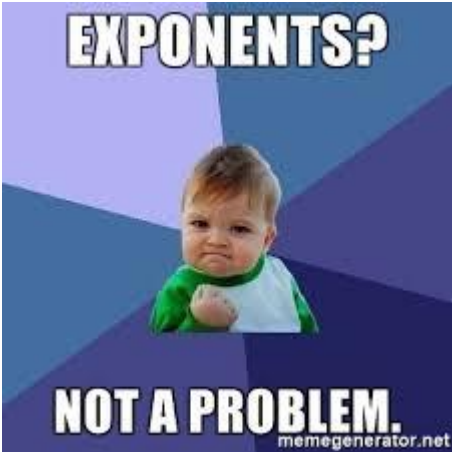**Answer:** 5^3 (expanded form is not required but hopefully I can see this in their work)

Extra Credit: Give a "real world" example of where exponents are used. **(critical thinking)**

Lesson 3

Grade: 9th		Subject: Algebra I; exponents	
Materials: Everyday classroom essentials		**Technology Needed: Smartboard, calculators, smart phone/device**	
Instructional Strategies: ☐ Direct instruction ☐ Guided practice ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☐ Technology integration ☐ Other (list)	☐ Peer teaching/collaboration/ cooperative learning ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☐ Modeling	**Guided Practices and Concrete Application:** ☐ Large group activity ☐ Independent activity ☐ Pairing/collaboration ☐ Simulations/Scenarios ☐ Other (list) Explain:	☐ Hands-on ☐ Technology integration ☐ Imitation/Repeat/Mimic

Standard(s)
 HS.N-RN.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 exponent
		Differentiation
		    Below Proficiency: these students will be given guided notes.
		
		    Above Proficiency: these students will be challenged by trying to teach the other students the rule they come up with	

Objective(s) **The students will be able to simplify powers of products.** **The students will know how to simplify power to a power expressions.** **The students will know how to apply this knowledge to an outside the classroom situation.** **Bloom's Taxonomy Cognitive Level: knowledge, application**		**Approaching/Emerging Proficiency: this lesson is made for these students as there is not much alternatives.** **Modalities/Learning Preferences: visual, social** KhanAcademy Video for extra support or reinforcement. https://www.khanacademy.org/math/pre-algebra/pre-algebra-exponents-radicals/pre-algebra-exponents/v/exponents-warmup	
Classroom Management- (grouping(s), movement/transitions, etc.) **Attention getter, proximity when lecturing, possible notecards for cold calling if there is no participation.**		**Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)** **Students should participate in class while still respecting my lecture time.**	

Minutes	Procedures
10	**Set-up/Prep:** Prepare the Kahoot, Prepare lecture notes
10	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** Bell Ringer: Summarize the exponent rules we have learned thus far and include an example that displays each rule. This picture will be posted on the screen with the question to add humor to the class.

10 **10**	**Explain: (concepts, procedures, vocabulary, etc.)** First, we will start with our first concept. I would start by proposing the problem $4^3 \cdot 4^2 = (4 \cdot 4 \cdot 4) \cdot (4 \cdot 4) = 4^5$. We would go over this in class with the majority of input coming from the students, as I am hoping they will recall rules from the previous lessons. Next, I will present $6^5 \cdot 6^2 = ? = 6^7$. I will have the students turn to their partners and determine what the answer to this question will be. After we have discussed this problem, I will give this one $3^5 \cdot 7^2 = ?$ and ask the class how to determine this problem. I will then ask the students if they think they can come up with a general rule for multiplying numbers with exponents. We will discuss what Next, we will address the power to a power questions. $(6^3)^3 = 6^3 \cdot 6^3 \cdot 6^3 = 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 = 6^9$. I will walk through this question one step at a time. Displaying how it models what we have been doing the last couple of days. I will present another example $(5^2)^3 = 5^2 \cdot 5^2 \cdot 5^2 = 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 5^6$. This example I will have students do either alone or with their partner. Then, I will ask if anyone thinks they have a general rule for a power to a power. If so, I will have them present it in front of the class. **If time allows, then we as a class will try to come up with some outside the classroom applications for these skills.**
10	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** Now, I will have the students use their smart device to go to kahoot.it where we will complete a variety of questions that involve skills we have worked on so far. This will help them review for the quiz tomorrow.
10	**Review (wrap up and transition to next activity):** The last ten minutes, I will have students begin to work on the homework I will assign from the book. A nice short assignment that will help establish and help the students practice this new rule.

Formative Assessment: (linked to objectives) **Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc.** The lesson has many check-in points along the way, and I will prompt each example with what are we to do next. **Consideration for Back-up Plan:** If students do not get the simplifying powers of products, I will model a couple more examples. If students need more examples of power to a power, then I will provide them. However, if they catch on right a way we can move on to the kahoot.	**Summative Assessment (linked back to objectives)** **End of lesson:** Homework assignment given at the end of the lesson. **If applicable- overall unit, chapter, concept, etc.:** These skills will be on the quiz and test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
Did students catch on to the rules too quickly? How did the class flow from partner work to whole class discussion?

Lesson 4

Grade: 9th	Subject: Algebra I; Exponents
Materials: everyday classroom essentials	Technology Needed: smartboard

Instructional Strategies:		Guided Practices and Concrete Application:	
☐ Direct instruction ☐ Guided practice ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☐ Technology integration ☐ Other (list)	☐ Peer teaching/collaboration/ cooperative learning ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☐ Modeling	☐ Large group activity ☐ Independent activity ☐ Pairing/collaboration ☐ Simulations/Scenarios ☐ Other (list) Explain:	☐ Hands-on ☐ Technology integration ☐ Imitation/Repeat/Mimic

Standard(s) HS.N-RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.	Differentiation **Below Proficiency: These students will receive guided notes**
Objective(s) The students will be able to rewrite radicals and rational expressions. **Bloom's Taxonomy Cognitive Level: knowledge, understand**	**Above Proficiency: These students will be encouraged to tutor others in the class.** **Approaching/Emerging Proficiency: The lesson is made for these students.** **Modalities/Learning Preferences: visual, auditory**

Classroom Management- (grouping(s), movement/transitions, etc.) Attention getting device, proximity, giving students time to turn and talk or brain breaks, humor, and note cards for cold call if need be. Establish the respect for the student presenting and how there will be no rude comments or anything of that sort.	Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.) Students should be respectful to others and be able to work well together and stay on task.

Minutes	Procedures
5	**Set-up/Prep: Set up notes and bell ringer**
10	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)**

	This will be a humorous note, and provide a good conversation starter to review the quizzes. I will encourage my students and praise them for their hard work.
25	**Explain: (concepts, procedures, vocabulary, etc.)** We will first do a quick review based off the quizzes on a common problem that people struggled with. Then I will go over how to write an expression that contains a negative exponent. $5^{-3} = \dfrac{1}{5^3} = \dfrac{1}{125}$. I walk through this question on the board and then have three additional questions that I will ask each student to complete on their own. Once the students are finished, I will ask who is going to show the class how they did the problem, and a different student will demonstrate the three different problems. Next, we will get into the tougher concept. Here is where I first explain how there is more than just a square root. I will demonstrate and show that there are third roots, fourth roots, fifth roots, and how this can go on forever. I will briefly show examples of one would solve the cube root, fourth root, and fifth root of different numbers. Then, now that I established this, I will demonstrate how this relates to exponents. I will show the students that one can rewrite the square root as an exponent of ½ and the cube root as 1/3 and so on. Then, I will show the students that if there is a numerator in the radical it means the number under the root is raised to that power. Thus, if we have $5^{\frac{2}{3}} = \sqrt[3]{5^2}$ and more examples similar to this of how one can go from radicals to exponents and exponents to radicals. Also, I will demonstrate how $7^{\frac{4}{3}} = \sqrt[3]{7^4} = \sqrt[3]{7^3 \cdot 7^1} = 7\sqrt[3]{7}$ and provide a couple more examples similar to this
12	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** Students will be given an assignment from the book that they can work on individually or with partners. This will help them continue to practice the rules and skills it takes to solve these problems
3	**Review (wrap up and transition to next activity):** I will have the students pack up and assert that the homework is due tomorrow and that we are going to move into exponential growth and decay tomorrow. Also, we will have a little research project.

Formative Assessment: (linked to objectives)
  Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc.
Monitoring the reactions and discussions during lecture.
 	
  Consideration for Back-up Plan:
I may have to lecture longer that I expected and then could cut down the problems on the assignment.
	Summative Assessment (linked back to objectives)
	  End of lesson: The homework assignment from the book will be given that demonstrates students' abilities to write expressions with radical exponents.
	
	  If applicable- overall unit, chapter, concept, etc.:
	This will be on the quiz and test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
Did students struggle with this concept and need more time? Did they have prior knowledge of radicals?

Lesson 5

Grade: 9th	Subject: Algebra I; Exponents
Materials: everyday classroom essentials	Technology Needed: computer or smart device
Instructional Strategies: ☐ Direct instruction ☐ Guided practice ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☐ Technology integration ☐ Other (list) ☐ Peer teaching/collaboration/ cooperative learning ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☐ Modeling	**Guided Practices and Concrete Application:** ☐ Large group activity ☐ Hands-on ☐ Independent activity ☐ Technology integration ☐ Pairing/collaboration ☐ Imitation/Repeat/Mimic ☐ Simulations/Scenarios ☐ Other (list) Explain:
Standard(s) HS.F-IF.8* Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function b. Use the properties of exponents to interpret expressions for exponential functions	**Differentiation** **Below Proficiency: Students will be given notes and placed in groups where students will help them.** **Above Proficiency: These students will need to lead the groups and teach others the problem they have chosen.** **Approaching/Emerging Proficiency: These students need to be good teammates and will not need much accommodation.** **Modalities/Learning Preferences: visual, social, auditory**
Objective(s) Students will understand and apply their knowledge to exponential growth and decay functions. **Bloom's Taxonomy Cognitive Level: knowledge, analysis**	
Classroom Management- (grouping(s), movement/transitions, etc.) **I will place colored cards on their desks to assign their groups for after lecture. Again, I will incorporate humor, proximity, and monitor groups and assisting when needed.**	**Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)** **Students should work well in groups and be able to present as a team and communicate their ideas to the class.**

Minutes	Procedures
5	**Set-up/Prep:** Set up notes, prepare colored cards, prepare video
5	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** I will start the class by showing a short film that has a real application to exponential growth. https://www.youtube.com/watch?v=VcSX4ytEfcE I will demonstrate that this is exactly what we are talking about today. (exponential growth and decay).
25	**Explain: (concepts, procedures, vocabulary, etc.)**

Growth:
$$y = a(1+r)^x$$

Decay:
$$y = a(1-r)^x$$

a = initial **amount** before measuring growth/decay
r = growth/decay **rate** (often a percent)
x = number of **time** intervals that have passed

I will give the students the following handout. We will go over both growth and decay problems and how to use the handout out. So, we will start with an exponential growth problem:

Mr. Doll is getting ready to go on vacation. The day before he leaves he makes an incredible dish of Mac N Cheese. However, he forgets it on the counter. While Mr. Doll is away, there were 5 bacteria on the pasta to begin. Then, they increased by 200% in number every twelve hours. If Mr. Doll was gone for seven days, how many bacteria were on his Mac N Cheese when he returned.

With this example, the class and I will identify a= 5 r= 200% which I will emphasize needs to be a decimal (so in this case 2). Now x is a little tricky. Since it happens every 12 hours and there are 24 hours, it happens twice a day for seven days. So, x= 14. Then we will solve.

For Decay: Mr. Doll buys a new car while on vacation. However, his car depreciates in value by 10% every 6 months. He bought his car for $32,000. How much would it cost after 5 years. Again, go through the same process and identify variables and walk the students through this problem.

15	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** This is when I will let the students get into groups of 2 or 3 and research or come up with an exponential growth or decay problem. I will explain that tomorrow they will have to present to the class and identify the different variables and walk the class through the calculations and how it applies to the problem.
5	**Review (wrap up and transition to next activity):** I will have the students pack up and tell them they will present their problems tomorrow in class. Also, they may have time to continue to work tomorrow before they present.

Formative Assessment: (linked to objectives) **Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc.** I will be prepared to use clarifying questions, or have students repeat to me what their task is when is to comes to the research part. **Consideration for Back-up Plan:** I can lecture for longer if I feel the students are confused about the concept.	**Summative Assessment (linked back to objectives)** **End of lesson:** The assessment will be the way the groups teach their specific problem. **If applicable- overall unit, chapter, concept, etc.:** The content of this lesson will be on the test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
How quick did students create or find a problem? Did they understand the problem and were able to explain it to the class?

Quiz 2 Lesson Plan

Grade: 9	Subject: Algebra I
Materials: Everyday classroom essentials, quiz	**Technology Needed: Projector**

Instructional Strategies:	**Guided Practices and Concrete Application:**
☐ Direct instruction ☐ Guided practice ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☐ Technology integration ☐ Other (list) ☑ **Peer teaching/collaboration/ cooperative learning** ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☐ Modeling	☐ Large group activity ☐ Hands-on ☑ **Independent activity** ☐ Technology integration ☑ **Pairing/collaboration** ☐ Imitation/Repeat/Mimic ☐ Simulations/Scenarios ☐ Other (list) Explain:

Standard(s)	**Differentiation**
HS.F-IF.8* Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function b. Use the properties of exponents to interpret expressions for exponential functions **HS.N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents. **HS.N-RN.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 exponent.	**Below Proficiency:** I will be sure to monitor these students while taking the test to help assist or provide the necessary resources for them to succeed while still challenging them. **Above Proficiency:** I will encourage these students to be peer teachers to the less proficient in the class. **Approaching/Emerging Proficiency:** I will challenge these students to help peer teach, as the old saying goes, you do not know the material until you can teach it. **Modalities/Learning Preferences:** intrapersonal and interpersonal
Objective(s) The students will be able to apply knowledge from previous material covered and apply it to the quiz. **Bloom's Taxonomy Cognitive Level:** application	

Classroom Management- (grouping(s), movement/transitions, etc.)	**Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)**
I will use the color cards to assign partners, but I will strategically place students with other students that I think will work well together. I will provide a timer projected on the board so that students can see when they should start transitioning and when the quiz will be handed out. Once students finish their quizzes I will ask them to continue to research and work on their growth and decay problem, and then when everyone finishes their quizzes I will let them join their groups.	I expect students to work well together and then concentrate on their respective quizzes.

Minutes	Procedures
5	**Set-up/Prep:** Print out the quizzes for class.
5	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)**

	Bellringer: Please achnolwedge three skills that you are struggling with. Please share these with your partners and be sure to review those skills before the test.
10	**Explain: (concepts, procedures, vocabulary, etc.)** This is when students will peer teach each other and review for the quiz.
25-35	**Explore: (independent, concreate practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** Students will take their quiz at this time. Then, when finished with their quiz they will continue to work on their growth and decay project.
0-5	**Review (wrap up and transition to next activity):** I will thank the students for their great work and remind them that tomorrow they will be presenting their problems.

Formative Assessment: (linked to objectives)	Summative Assessment (linked back to objectives)
Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc. I will collect the bell ringer for no grade to see if there is something common all students are struggling with. I will also monitor group review to see if students are on task and using the time wisely. **Consideration for Back-up Plan:** If students aren't working well after the quiz, I will just review the common struggles and assign the group project for homework for them to present tomorrow.	**End of lesson:** The quiz and growth and decay project that will be presented tomorrow. **If applicable- overall unit, chapter, concept, etc.:** The quiz and growth and decay information will be on the test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):
Did students review well together? After the quiz, were they productive with the time they had to work on their project? What can I do to facilitate review time better? Should I give them the choice of reviewing independently and/or with a partner?

Exponents Quiz 2

Directions: Please rewrite these expressions as a number with an exponent, or a number with a radical.

1. $6^{\frac{4}{3}}$

2. $\sqrt[18]{23^7}$

$6\sqrt[3]{6}$

$23^{\frac{7}{18}}$.

3. $\sqrt[7]{4^5}$

4. $13^{\frac{5}{6}}$

$4^{\frac{5}{7}}$

$\sqrt[6]{13^5}$

Directions: Please complete the following questions and circle/box your answer. Please identify what a, r, and x are equal to. Show all your work.

5. One day, before you left for school, you left your pop-tart and milk on the counter. There is a special kind of bacteria called *milkarhea* that finds this milk. There were two of them to begin but after just 15 minutes they increased by 75%. How many *milkarhea* were in your milk when you returned home from school 7 hours later? Round to the nearest whole number.

A= 2 r=.75 x= 28, 12767191

6. Tomorrow you will win the lottery and go buy a brand new pickup worth $85,000. As you drive away, you know the value of your pickup will decrease 5% every 3 months. How much is your pickup worth after 3 years.

A= 85,000 r= .05 x= 12 , $45930.61

Extra-Credit: Create your own unique exponential growth or decay word problem and the solution.
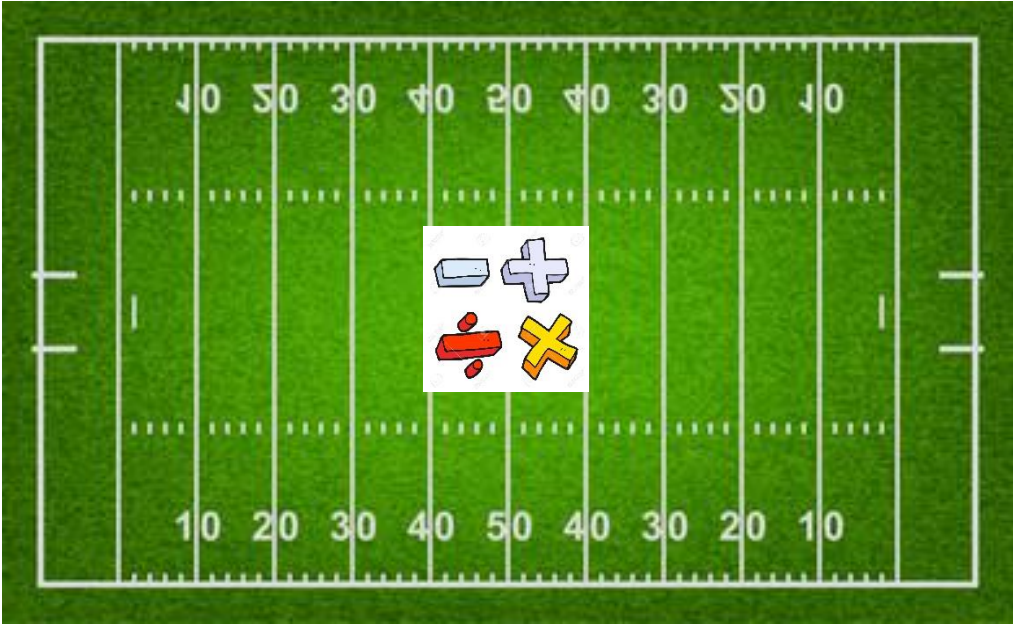
Lesson 6

Grade: 9th	Subject: Algebra I; exponents
Materials: Everyday classroom essentials	Technology Needed: smart board, computers or smart device

Instructional Strategies: ☐ Direct instruction ☐ Guided practice ☐ Socratic Seminar ☐ Learning Centers ☐ Lecture ☑ Technology integration ☐ Other (list) ☑ Peer teaching/collaboration/ cooperative learning ☐ Visuals/Graphic organizers ☐ PBL ☐ Discussion/Debate ☑ Modeling	Guided Practices and Concrete Application: ☑ Large group activity ☑ Hands-on ☐ Independent activity ☑ Technology integration ☑ Pairing/collaboration ☐ Imitation/Repeat/Mimic ☑ Simulations/Scenarios ☐ Other (list) Explain:
Standard(s) HS.F-IF.8* Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function b. Use the properties of exponents to interpret expressions for exponential functions	Differentiation **Below Proficiency: I will be sure to help these students and make sure they are prepared to share when called upon by checking that they have their portion correct which will lead to success.** **Above Proficiency: These students should take the lead and be able to teach their problems.** **Approaching/Emerging Proficiency: These students should be able to contribute and be challenged by the students teaching their problems.** **Modalities/Learning Preferences: visual, auditory, hands-on**
Objective(s) Students will understand and apply their knowledge to exponential growth and decay functions. **Bloom's Taxonomy Cognitive Level: synthesis**	
Classroom Management- (grouping(s), movement/transitions, etc.) **I will use purposeful proximity, be sure to control what students are saying and doing during someone's presentation. I will use the attention getter if need be between students' problems.**	Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.) Students should be respectful and taking notes when their classmates are presenting

Minutes	Procedures
5	**Set-up/Prep: Have groups and computers ready**
3	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)** Welcome the students to class remind them of the project they were working on and let them get into their groups to begin working.
5	**Explain: (concepts, procedures, vocabulary, etc.)** I will be sure to remind students the proper way to give a presentation. I will explain in between groups presenting to clarify and summarize what they presented.
40	**Explore: (independent, concrete practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** I will have 5-10 minutes for the groups to finish researching and getting their problems ready to present. Then with the remaining 30-35 minutes the groups will present their exponential growth or decay problems.

2	**Review (wrap up and transition to next activity):** I will take two minutes to wrap up and thank the students for doing this. I will remind them that we are reviewing tomorrow and then taking the test the following day.

Formative Assessment: (linked to objectives)	Summative Assessment (linked back to objectives)

Progress monitoring throughout lesson- clarifying questions, check- in strategies, etc.
   I will be sure to ask groups to touch on things they didn't cover or that I would like them to explain more about. I will require the students to be taking notes during the presentations.
 	
 Consideration for Back-up Plan:
 If students aren't paying attention, then I will ask for the notes and the problems from each group.
	End of lesson: The presentation.
	
	  If applicable- overall unit, chapter, concept, etc.:
	 These skills will be needed for the test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?):

How long did the presentations take? Did the students learn from this? Did the students listening to the presentation gain knowledge from the many different examples?

Lesson 7

Grade: 9th	Subject: Algebra I; Exponents
Materials: Everyday classroom essentials	**Technology Needed: Smartboard/ projector**

Instructional Strategies:		**Guided Practices and Concrete Application:**	
☐ Direct instruction	☐ Peer teaching/collaboration/ cooperative learning	☐ Large group activity ☐ Independent activity ☐ Pairing/collaboration ☐ Simulations/Scenarios ☐ Other (list) Explain:	☐ Hands-on ☐ Technology integration ☐ Imitation/Repeat/Mimic
☐ Guided practice	☐ Visuals/Graphic organizers		
☐ Socratic Seminar	☐ PBL		
☐ Learning Centers	☐ Discussion/Debate		
☐ Lecture	☐ Modeling		
☐ Technology integration			
☐ Other (list)			

Standard(s)	**Differentiation**
HS.N-RN.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 exponent	**Below Proficiency: This will be good for them as they will not have much pressure on them but can still contribute and practice their skills.**
HS.F-IF.8* Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function	**Above Proficiency: I will challenge them to be the leaders of the group and teach the group members along the way.**
b. Use the properties of exponents to interpret expressions for exponential functions	**Approaching/Emerging Proficiency: Again, this lesson is perfect for them, as it fits their skill set.**
	Modalities/Learning Preferences: kinesthetic, visual, audio
Objective(s) The students will be able to complete all the review problems.	
Bloom's Taxonomy Cognitive Level:	

Classroom Management- (grouping(s), movement/transitions, etc.)	**Behavior Expectations- (systems, strategies, procedures specific to the lesson, rules and expectations, etc.)**
I will need to monitor the groups and be aware of their behaviors and action. I will need to make sure the board is accessible and doesn't cause controversy.	**The students should work well together and take turns marking the boards.**

Minutes	Procedures
5	**Set-up/Prep: Prepare the questions for review and put the field on the board.**
1	**Engage: (opening activity/ anticipatory Set – access prior learning / stimulate interest /generate questions, etc.)**

	Again, I like to start my students class period off with a little humor to lighten the mood. Also
5	**Explain: (concepts, procedures, vocabulary, etc.)** **(this will be the picture on the smartboard)** I will explain to the students our review game. I will divide the group into four or five teams. I will let them select their team name. Then each team will start on the goal line. I will have 12 questions prepared containing the material we covered in class. Each group member must complete and answer the question correctly, when they one of the group members must bring me their problem to get signed by me. Once I sign it, they will move their team up ten yards and grab another question. Once they score get to the touchdown, they will need to "kick the extra point" and answer another question. Then, if there is time we will have a sudden death question to see who wins.
40	**Explore: (independent, concreate practice/application with relevant learning task -connections from content to real-life experiences, reflective questions- probing or clarifying questions)** This will be when the teams are working through their problems and moving ten yards at a time.
4	**Review (wrap up and transition to next activity):** I will have the students pack up and remind them of the test tomorrow and thank them for their participation.

Formative Assessment: (linked to objectives)
  Progress monitoring throughout lesson-clarifying questions, check- in strategies, etc.
  I can hear and monitor groups conversations.
	Summative Assessment (linked back to objectives)
	  End of lesson: There is no summative assessment, besides the different questions I will look at and sign.

Consideration for Back-up Plan: If the game is done early, I can always have more questions prepared for an "overtime"	**If applicable- overall unit, chapter, concept, etc.:** This was review for the test.

Reflection (What went well? What did the students learn? How do you know? What changes would you make?): Did the game go too fast? Was there enough time? Were the questions too easy?

Connor Doll   Unit Plan- Exponents

Name:_____   Period:_____

<p style="text-align:center">Mr. Doll's Exponent Test</p>

Directions: Please be sure to follow the directions on every page. You are not allowed to talk to your neighbor, use your phone, or use your notes at any time during this test. You may only use a calculator, pen/pencil, and your brain. If you have questions, please ask me for clarification. **Show all your work, as you will be given partial credit if you have the correct steps even though you have the wrong answer.** The test will be collected as soon as the bell rings. Good luck! (you will NOT need it!)

Connor Doll Unit Plan- Exponents

Directions: Please write the following expressions in expanded form.

1. 7^4

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

2. 4^6

$4 \cdot 4 \cdot 4 \cdot 4 \cdot 4 \cdot 4$

3. 9^3

$9 \cdot 9 \cdot 9$

Directions: Please **simplify** then **solve** each expression.

4. $(7^2)^5$

$7^{10} =$ **282,475,249**

5. $3^7 \cdot 3^7$

$3^{14} =$ **4,782,969**

6. $\dfrac{4^3}{4^3}$

$4^0 =$ **1**

7. $2^6 \cdot 2^5$

$2^{11} =$ **2048**

8. $\dfrac{5^3}{5^7}$

$5^{-4} = \dfrac{1}{625}$

9. $3^4 \cdot 5^2$

Simplified = 2,025

10. $(9^3)^3$

$9^9 = \textbf{387,420,489}$

11. $\dfrac{8^7}{8^3}$

$8^4 = \textbf{4096}$

12. $4 \cdot 4^5$

$4^6 = \textbf{4096}$

13. $\dfrac{6}{6^3}$

$6^{-2} = \dfrac{1}{36}$

14. Please give an example where exponents are used in the "real world." **Use complete**

sentences.

One example of where exponents are used is in science when measuring how small some

bacteria are.

Directions: Please complete the following problems showing all work. Please identify what a,r, and x are in each problem.

15. There are 30 students at school with the flu on Monday. The amount of people who catch the flue increases by14% per day. Approximately how many students will have the flu on Friday? Round your answer to the nearest whole number because you cannot have a fraction of a person.

A= 30 r=.14 x= 4 , 50.66 approximately 51

16. Scientists have finally found a chemical that is killing mosquitos. If there are 100,000 mosquitos in the area where they are spraying the chemical, and the chemical decreases the population by 6% every time they spray. How many mosquitos are left after they spray 10 times? Round your answer to the nearest whole number.

A= 100,000 r= .06 x=10 53861.51 approximately 53862

17. Mr. Doll puts $3,000 in an account that increases his earnings by 3% every year. How much money will Mr. Doll have in his account after 25 years?

A= 3000 r=.03 x=25, $6281.33

18. Please list at least two of the exponent rules you used on this test.

Product of powers where the exponents are added when they have the same base.

Power to a Power, where the exponents are multiplied.

Extra Credit: What was the name of the exponent song we listened to earlier in this unit?

"All About That Base"