TITLE OF LESSON: Mentos and Math -An Explosive Mixture!

 CONTEXT OF LESSON: In this Algebra 2 lesson, students will collect and analyze data, and then they will create an exponential model to answer a real-world problem. This lesson will be used after students have been introduced to exponential functions. They should be familiar with both the shape and the standard form for an exponential function before they attempt this lesson.

Although this lesson requires lots of materials and can be expensive to obtain supplies, it is well worth it to see the excitement of how math can be used to answer real-world problems. I recommend having the students bring in some of the supplies ( ie. Mentos) I obtained the graduated cylinders from our Science dept.

LEARNING OBJECTIVES AND ASSESSMENT:

|  |  |  |
| --- | --- | --- |
| **Learning Objective** | **Bloom** | **Assessment** |
| Collect data. | 1 | Formative: The warmup will be collected and recorded so the teacher can pinpoint issues to clarify.Formative: The Lab will be completed and turned in and scored by the Rubric that is attached. |
| Analyze data to write an exponential model.  | 3 |
| Determine the equation of the curve of best fit for the exponential model. | 2 |
| Make predictions using the exponential model. | 2 |
| Solve a real-world problem using the exponential model. | 3 |
| Create a real - world scenario, given an exponential model. | 4 |  |

**RELATED 2009 VIRGINIA SOL: AII.9**

The student will collect and analyze data, determine the equation for the curve of best fit, make predictions, and sole real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.

**MATERIALS NEEDED: Each group will need:**

One - 2L bottle (room temperature) of Diet Coke

 1 - 7 Mentos, depending on group number

 One -250 ml graduated cylinder

 One – 100 ml graduated cylinder (Used for experiments with more than 1 Mento)

 Index card

Strip of masking tape and a marker

PROCEDURE

DAY 1

|  |  |  |
| --- | --- | --- |
| Time | Mathematical Tasks: Teacher | Student actions/ questions |
| 15 | Warmup: Use “Pairs Check With A Switch” to review Exponential Functions from previous lesson.Pair the students in advance.Discuss answers; collect | Students may mix up what the “a” value and “b” values represent in the standard form of the exponential function.Discuss answers to warmup to clarify issues. |
| 5 | Show the video to engage students in the lesson: <http://www.teachertube.com/viewVideo.php?video_id=8667&title=Diet_Coke_and_Mentos>The teachertube site was used because youtube is not accessible at many schools.After the video, pose the question:What is the minimum number of Mentos used to totally erupt a 2L bottle of Diet Coke?  |  |
| 30 | 1) Assign students to groups of 2 or 3 and give each group a # from 1 to 7. 2) Distribute Directions to Mentos Lab.3) Explain Procedure for the data collection.Each group will only do one Mentos experiment. For example, Group #1 will be given 1 Mento to do their experiment, group #2 receives 2 Mentos, group 3 receives 3 Mentos, etc.If you have more than 21 students, you may want to obtain extra Mentos and bottles of 2L soda so that some parts of the experiment can be replicated. Two groups can do 6 Mentos and 2 groups do 7 Mentos since there is more room for error with these two experiments.4)Have students perform the lab OUTSIDE away from cars, windows, or anything else that could get sticky from the explosion. (You can decide whether you want them to all do their explosions at the same time, or I recommend doing one at a time- nobody wants to miss the ones with 5-7 Mentos- this actually goes fairly quickly.) 5) After each group has performed their lab, make sure they do not dispose of the remaining liquid in the bottle. They will put the masking tape on their bottle and mark it with their group number.6) Bring bottles back inside classroom and align them from 1 – 7. Students should be able to see the remaining liquid creates an  exponential decay function right before their very eyes.7) Wrap-up : Teacher should have them guess the answer to the question posed at the beginning of the lesson. | Students will write their guess to the question that was posed. |

DAY 2

|  |  |  |
| --- | --- | --- |
| Time | Mathematical Tasks: Teacher | Student actions/questions |
| 15 | 1)Teacher distributes the remaining part of the Lab sheet for phases 2 and 3 and directs students to complete Phase 2. 2) Monitor for correct measurements of liquid remaining in the bottle.3) Have students write their data on a class chart that is on the board. All students need to copy this data.\*In the case where a lab was replicated ( 6 or 7 Mentos), you’ll need to discuss how to record the data. ( An example would be to average the results.)When all data is on the class chart, ask whether the chart seems to show an exponential function. Have them compare the ratio of consecutive terms. | Students get back into the same groups. Students obtain any 2L bottle from the previous day and complete Phase 2.Students copy data for Phase 2. |
| 25 | Students complete Phase 3 in their groups.Turn in Lab.  | Students will turn in the Lab upon its completion. |
| 5 | Wrap-up the lesson with this question:In a related experiment, students came up with the equation,Explain the significance of each value as it relates to the experiment. | Students will write their answer and turn it in to teacher. |

MEETING THE NEEDS OF ALL STUDENTS:

Teacher carefully planning the Grouping of students will assist those students who are below grade level. Accelerated students have the option to do an extension of the experiment, as listed at the end of the student handout.

WHAT COULD GO WRONG WITH THIS LESSON:

The data can be skewed: students could knock over/ drop the bottle before or after the experiment, or just measuring inaccurately. I have provided data for an experiment that I have already completed. Use it as a backup.

CONNECTION TO CTA:

I used this lesson last year. The following changes were made to incorporate gems that I picked up during CTA.

I included a rubric. Brian Nussbaum’s examples helped me to realize that a rubric not only helps the student define how they are performing, it is an easy way for the teacher to grade the project. I used the Rubistar site which made the process even easier.

I added a wrap-up question at the end where I present the equation and they have to write the scenario as was suggested in Lintner’s session on open ended tasks.

I also incorporated Streebe’s Pairs Check With A Switch to connect the previous lesson. To the current lesson.

**BLUE Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Exponential Functions**

|  |  |
| --- | --- |
| **check** | **Question** |
|  | 1. The following function is an exponential \_\_\_\_\_\_\_\_\_\_ function.  |
|  | 2. The coordinates of the y-intercept of  are \_\_\_\_\_\_\_\_\_\_\_ |
|  | 3. Write an exponential function to represent the pattern.  Hour 1 = 40 Hour 2 = 60 Hour 3 = 90 Hour 4 = 135 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
|  | 4. Which do not represent exponential growth functions? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_a)  b) c)  d)  |
|  | 5. The population of a town in 1990 was 50,000. The population of the town has grown by 1 percent each year. Write the exponential function that models the town’s population since 1990.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**GREEN Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Exponential Functions**

|  |  |
| --- | --- |
| **check** | **Topic: Exponential Functions** |
|  | 1. The following function is an exponential \_\_\_\_\_\_\_\_\_\_ function.  |
|  | 2. The coordinates of the y-intercept of  are \_\_\_\_\_\_\_\_\_\_\_ |
|  | 3. Write an exponential function to represent the pattern.  Day 1 = 2000 Day 2 = 400 Day 3 = 80 Day 4 = 16 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
|  | 4. Which do not represent exponential growth functions? \_\_\_\_\_\_\_\_\_a)  b)  c)  d)  |
|  | 5. Due to the economy, the value of a house has been decreasing by 3% per year since 2008. In 2008, the house value was $425,000. Write an exponential equation that models the value of the house since 2008.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

Group:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the minimum number of Mentos used to totally erupt a 2L bottle of Diet Coke?

Your guess\_\_\_\_\_\_\_

**Materials:** Each group needs:

 One - 2L bottle (room temperature) of Diet Coke

 1- 7 Mentos, depending on group number

 One -250 ml graduated cylinder

 One – 100 ml graduated cylinder (Used for experiments with more than 1 Mento)

 Index card

Phase 1: Collect the data

Step 1: Remove the cap from the Diet Coke and place it on a flat surface.

Step 2: \*\*Drop the Mento(s) and move away quickly to avoid getting wet!

Step 3: After the eruption, pour the remaining Diet Coke into the 250 ml cylinder and

 record the “leftover” volume on the chart.

\*\*When using more than 1 Mento, you can use the 100 ml cylinder to pour them in the Diet Coke so they drop at about the same time. You can do this by having a partner cover the Diet Coke’s opening with an index card. Next, stack the Mentos in the smaller cylinder and turn it upside down so that it rests on the index card which covered the Coke bottle’s opening. Have your partner SLOWLY slide the card out from between the cylinder and the bottle. (SLOWLY enough so the bottle doesn’t tip or some may fall in the Diet Coke and some may drop on the ground- DESTROYING your experiment!)

Phase 2: Share the DATA: Record the Data from the other experiments.

|  |  |
| --- | --- |
| Number of Mentos | Volume of remaining liquid (ml) |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |

Phase 3: Analysis of Data

1. What is the independent variable ?

2. What is the dependent variable?

3. What is the Domain?

4. What is the Range?

5.. Does the data appear to fit a linear function? How do you know?

6. Graph the data. (Remember to label axes and show the scale)

y

x

7.. What are the coordinates of the y-intercept? Explain the practical meaning of the y-intercept in

 this situation.

8. The function should appear to be an exponential function.

 a.) Using the model, , what is the value of ***a*** in this experiment? Explain.

 b) Using the model,  , what is the value of b in this experiment? Explain..

 c) Write the exponential function that models this experiment.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.. Use your calculator to make a scatterplot of the data, then find the exponential regression model

 (ExpReg)for the data. Round to 3 decimal places \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 How does your equation from part 9c compare to exponential regression equation?

11. Use this equation to extrapolate data to find the remaining volume if ….

 10 Mentos are used\_\_\_\_\_\_\_\_

 50 Mentos are used \_\_\_\_\_\_\_\_

 200 Mentos are used\_\_\_\_\_\_\_\_

12. How many Mentos will it take to fully erupt a 2L bottle of Diet Coke?

 In other words, how many Mentos will it take to make the remaining volume 0?

 How do you know?

Extension of the activity: Choose one from below.

* If you choose, A or B, perform the activity ( pictures would be great), then present the data in the same format as in today’s investigation.
* If you choose option C, present a written report of your explanation. Include your references.

A) Do colored Mentos work just as well as plain mint Mentos?

B) Do Mentos have the same effect on other soft drinks? (ie regular Coke, Sprite)

C) Explain why Mentos cause the eruption.

My data

|  |  |
| --- | --- |
| Number of Mentos | Volume of remaining liquid (ml) |
| 0 | 2000 |
| 1 | 1420 |
| 2 | 1004 |
| 3 | 746 |
| 4 | 718 |
| 5 | 672 |

Curve of best fit: y=  r = -.96

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CATEGORY  | **4**  | **3**  | **2**  | **1**  |
| **Graph**  | All components of graph are correct: Both axes are labeled with variables and units; axes are scaled; all points are plotted  | One component of graph is incorrect  | Two components of graph are incorrect  | More than two components of graph are incorrect  |
| **Exponential Equation**  | Equation is correct and both a and b values are correctly explained for the scenario  | Equation is correct. Either a or b value is not correctly explained for the scenario.  | Equation is correct. Both a and b values are incorrectly explained.  | Equation is incorrect. Both a and b values are incorrectly explained.  |
| **Prediction**  | Exponential regression equation is correct; All predictions are correct.  | Exponential regression equation is correct; Most predictions are correct  | Exponential regression equation is incorrect. Predictions are correct based on the Regression equation that was written.  | Exponential Regression equation is incorrect. Some predictions are correct based on the regression equation that was written.  |
| **Final analysis question**  | Answer is correct and explanation is detailed and shows full understanding of the topic.  | Answer is correct and the explanation shows a good understanding of the topic.  | Answer is incorrect. The explanation is a little difficult to understand. Shows a good understanding of parts of the topic.  | Answer is incorrect. The explanation is difficult to understand- does not seem to understand the topic.  |
| **Participation**  | Student was engaged partner and worked cooperatively throughout the lesson . | Student was engaged but had trouble cooperating with partner.  | Student cooperated with partner, but needed prompting to stay on task.  | Student did not work effectively with partner.  |

Rubric: Mentos and Math Lab Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 My Partners\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_