Lab Framework

Text: **CORD**

Unit number and title: **Unit 18 - Solving Problems that Involve Nonlinear Equations**

Short Description: **Investigation highlighting the difference among linear growth, quadratic growth, and exponential growth. (Also decay if time permits.)**

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GROWTH OF SKITTLEIUM

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**

  Students can…

    1. Explain the difference between linear and nonlinear functions.
    2. Explain the difference between quadratic and exponential functions in terms of growth (and decay if time permits).

- **Statement of pre-requisite skills needed**

  Graphing points from a set of data.

  Independent and Dependent Variables

- **Vocabulary**

Independent Variable	Quadratic
Dependent Variable	Parabola
Linear	Exponential

- **Materials List**

  Bags of Skittles (about 100 Skittles per group)

  NOTE: 3 "normal" size bags of Skittle contain a little over 100 Skittles. If you buy the "bulk" size you may need to separate into bags. The 100 Skittles is a nice, pretty number, but you can definitely have more or less Skittles. (The more the better.)

  Lab Sheet

  Pizza Boxes (one per group)

  NOTE: Any container in which students can SHAKE the Skittles will do. Pizza boxes are nice because they can open the boxes and the Skittles will be laying flat in a "walled" container. A bag will work, but students will have to pour the Skittles out.

- **State Standards addressed**

  Math: A1.1.A – Select and justify functions and equations to model and solve problems.

  A1.3.B - Represent a function as a graph, in a table, and using words, and make connections among these representations.

  A1.5.A - Represent a quadratic function as a graph, in a table, and using words, and make connections among these representations.

  A1.5.B - Sketch the graph of a quadratic function.

  A1.7.A - Sketch the graph of an exponential function.

  Reading: 2.1 – Demonstrate evidence of reading comprehension.

- **Leadership Skills**

  2.8 - The student will demonstrate the ability to incorporate and utilize the principles of group dynamics in a variety of settings.

- **SCAN Skills/Workplace Skills**

  Resources C: Materials and Facilities.

  Interpersonal A: Participates as a Member of a Team.

  Interpersonal F: Works with Diversity.

  Information A: Acquires and Evaluates Information.

- **Set-up information**

  If you buy bulk bags of Skittles, it is recommended that you separate the Skittles into sealable bags to make distribution easier. **The Skittles should NOT be placed directly into the Pizza Box.**

- **Lab organization**

  It is best for students to complete this lab in partners, although a group of three will work.

- **Teacher Assessment of student learning**

  Data Collection Sheets will contain assessment questions.

- **Summary of learning**

  Students will be asked to share what they have learned in class verbally.

- **Optional activities**

  If time permits, students can also do the "Decay of Skittleium" lab.

- **Career Applications**

  Business – Trends of data

  Compound Interest

  Home Economics – Compound Interest

  Exponential Growth/Decay

  Science - Exponential Growth/Decay

LAB TITLE: <u>GROWTH OF SKITTLEIUM</u>

- **Statement of problem addressed by lab**

    Giving a concrete example of linear, quadratic, and exponential growth through the use of Skittles!

- **Grouping instructions and roles**

    <u>Partners</u>

    One partner shakes and counts, the other partner records the information. They will switch with each experiment.

    <u>Groups of 3</u>

    One member records.

    Second member counts Skittles.

    Third member shakes and serves as the "back-up" counter.

    They will rotate jobs with each experiment.

- **Procedures** – steps to follow/instructions

    Follow instructions on DATA COLLECTION SHEET

- **Outcome instructions**

    Student will fill in the DATA COLLECTION SHEET.

- **Assessment instructions** (peer-teacher)

    Each student will

GROWTH OF SKITTLEIUM
Unit 18

WHAT IS SKITTLEIUM?
Skittleium is a radioactive material found in vending machines throughout the world. They are tricky little morsels disguised as candies in pretty red bags. Their fruit flavored taste hides the danger within.

HOW DOES SKITTLEIUM GROW?
Good question! That's what we're going to find out. You will be doing three different experiments during this lab. At the end, we will find out the rate at which Skittleium grows. (If we have time, we will watch Skittleium decay into a safer isotope that is edible!)

YOU WILL NEED:
This DATA COLLECTION SHEET
A pizza box
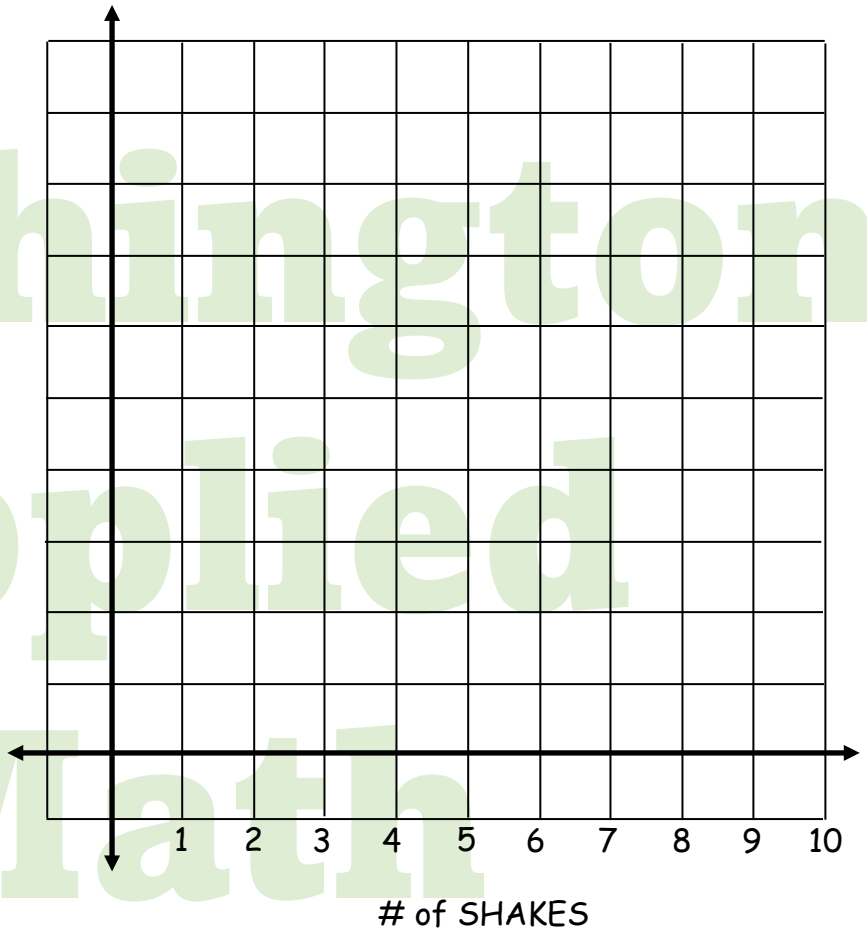A bag of "Skittles"

EXPERIMENT #1

HERE'S WHAT TO DO:
1. Do not eat the Skittleium
2. Place 4 Skittleium in the pizza box. Record the number of Skittleium in the table below as "Shake #0."
3. Shake it.
4. Open the box and place 2 more Skittleium in the box. Record the TOTAL number of Skittleium as "Shake #1." Close the box.
5. Repeat steps 3 and 4 until you get to Shake #9. (Please use "Shake #2," "Shake #3", etc to record your data.)
6. Plot the points onto the graph. You will need to determine the intervals for the vertical scale yourself. Draw a smooth curve/line through the points.

https://wa-appliedmath.org/

Shake #	Skittleium
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

1 2 3 4 5 6 7 8 9 10

# of SHAKES

1. Is this a linear or nonlinear function? _____

   If it's non-linear, what type of function do you think it is? _____

2. Describe the rate of growth of the Skittleium in this experiment.
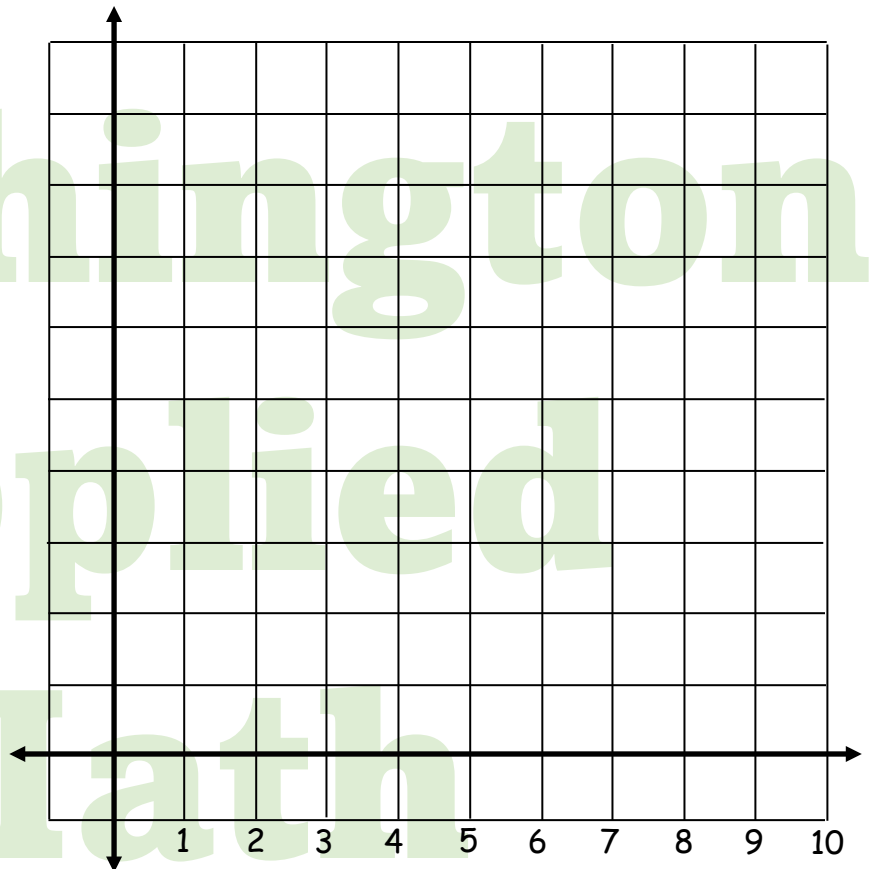
   _____

   _____

   _____

   _____

This is the crazy one. Be careful. Follow the directions CAREFULLY!
HERE'S WHAT TO DO:

1. Remove all the Skittleium from the pizza box.

2. Place 4 Skittleium in the pizza box. Record the TOTAL number of Skittleium in the table below as "Shake #0."

3. Shake it.

4. Open the box. Add **1** Skittleium to the box. Record the TOTAL number of Skittleium as "Shake #1."

5. Shake it.

6. Open the box. Add **3** Skittleium to the box. Record the TOTAL number of Skittleium as "Shake #2."

7. Shake it.

8. Open the box. Add **5** Skittleium to the box. Record the TOTAL number of Skittleium as "Shake #3."

9. Shake it.

10. Open the box. How many Skittleium will you add this time? (Check with Mr. Hill before moving on.) Add that number of Skittleium.

11. Repeat the "Shake and Open" steps until all your Skittleium are gone. Add more rows to the table if necessary. **Remember to add the correct number of Skittleium each time!**

12. Plot the points onto the graph. You will need to determine the intervals for the vertical scale yourself. Draw a smooth curve/line through the points.

Shake #	Skittleium
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

1   2   3   4   5   6   7   8   9   10

# of SHAKES

1. Is this a linear or nonlinear function? _____

    If it's non-linear, what type of function do you think it is? _____

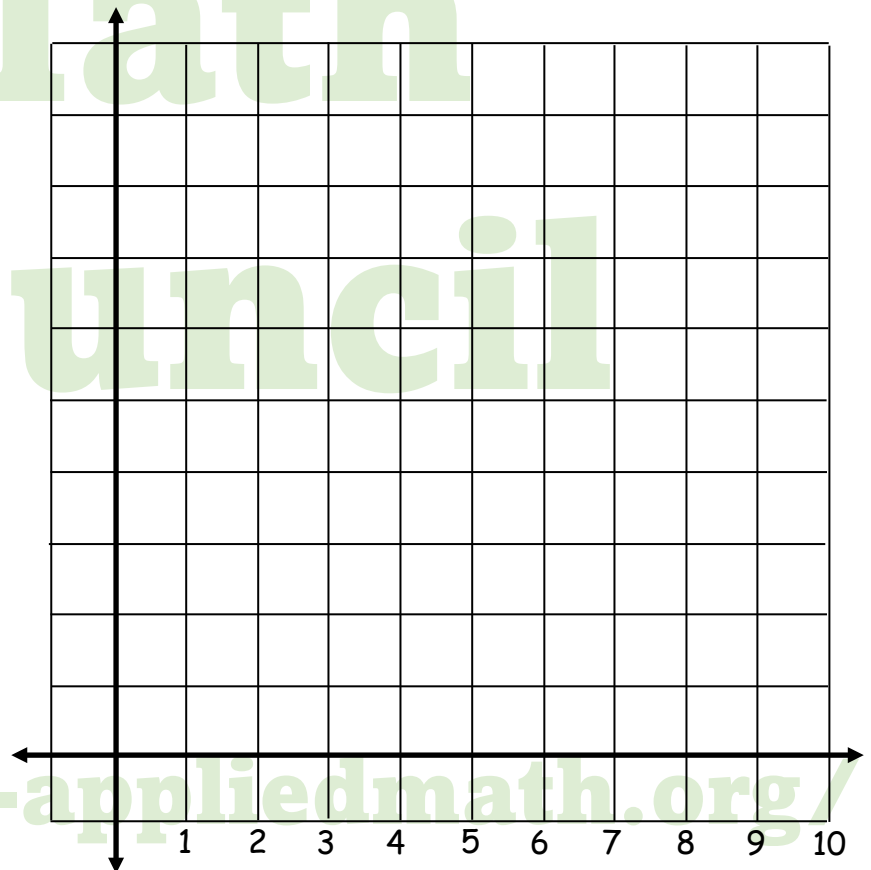2. Describe the rate of growth of the Skittleium in this experiment.

    _____

    _____

    _____

    _____

EXPERIMENT #3

HERE'S WHAT TO DO:

1. Remove all the Skittleium from the pizza box.

2. Place 4 Skittleium in the pizza box. Record the number of Skittleium in the table below as "Shake #0."

3. Shake it.

4. Open the box. Count the number of "S" that are showing.

5. Put <u>one</u> Skittleium into the box for every "S" that is showing. Record the TOTAL number of Skittleium in the box as "Shake #1."

6. Repeat steps 3-5 until you have no more Skittleium to put in the box.

7. Plot the points onto the graph. You will need to determine the intervals for the vertical scale yourself. Draw a smooth curve/line through the points.

Shake #	Skittleium
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

# of SHAKES

1. Is this a linear or nonlinear function? _____

   If it's non-linear, what type of function do you think it is? _____

2. Describe the rate of growth of the Skittleium in this experiment.

   _____

   _____

   _____

   _____

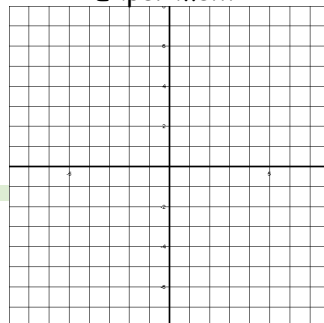3. In which experiment did the Skittleium grow the fastest? _____

4. Explain the difference between the rate of growth in Experiment #2 and the rate of growth in Experiment #3.

   _____

   _____

   _____

5. If you could go into "negative shakes" (that is, into the negative x-axis), what would happen to that portion of each graph? Copy your graphs from your experiments onto the axes below then sketch the "negative x" portion of the graph.
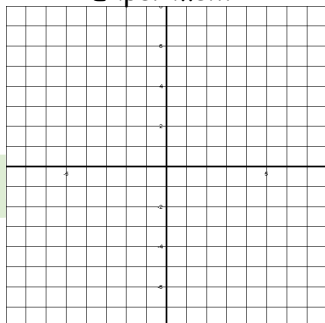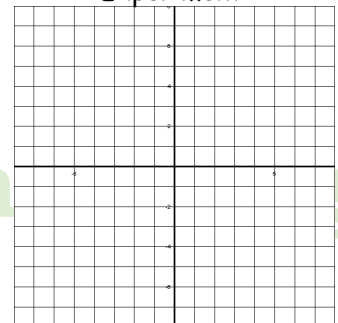
Experiment 1   Experiment   Experiment

SKITTLEIUM LAB WRAP-UP

1. The growth of Skittleium is modeled by the equation $y = 2^x + 4$. Use an x-y chart and/or sketch of this graph to find out which Experiment best represents the growth of Skittleium.

   Experiment _____ best represents the growth of Skittleium.

   Explain how you know: _____

   _____

   _____

2. Experiment 1 represents a linear function. How would you describe the rate of growth of <u>any</u> linear function? (Not just the one you did.)

   _____

   _____

3. Experiment 2 represents a quadratic function. How would you describe the rate of growth of <u>any</u> quadratic function? (Not just the one you did.)

   _____

   _____

4. Experiment 3 represents an exponential function. How would you describe the rate of growth of <u>any</u> exponential function? (Not just the one you did.)
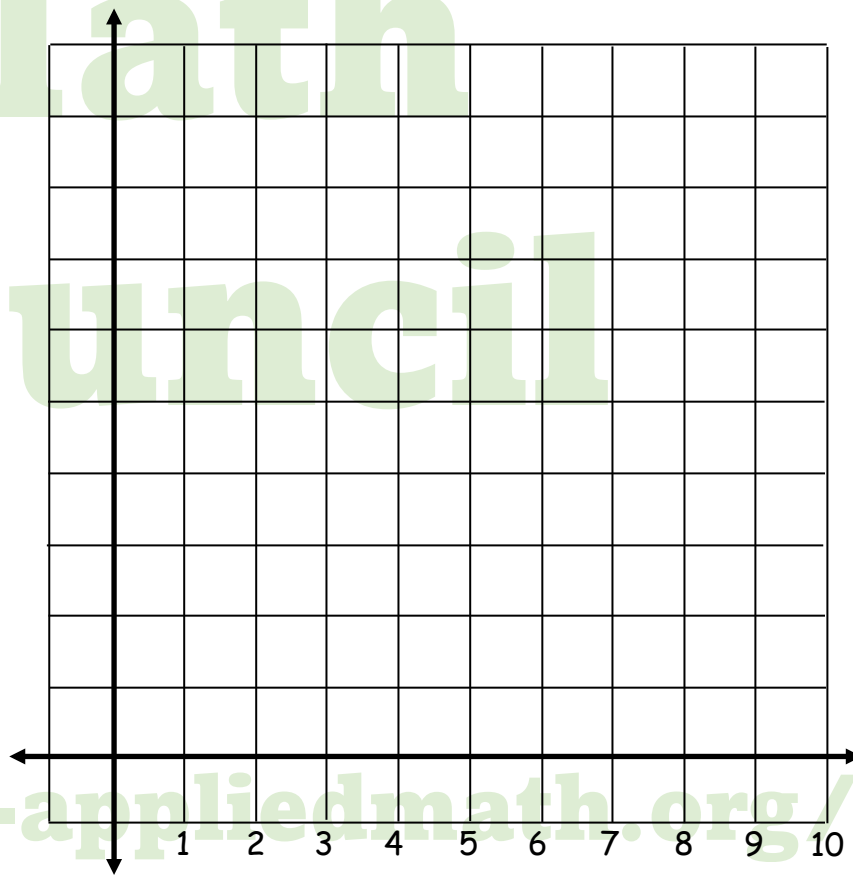
   _____

   _____

HERE'S WHAT TO DO:

1. The Skittleium have been the box too long. They are starting to decay into the non-radioactive isotope known as "Skittles." These are safe to eat.
2. Count any remaining Skittleium that <u>are not in the pizza box</u>. Add them to the pizza box. Record the TOTAL number of Skittleium as "Shake #0."

3. Shake it.
4. Open the box. Count the number of Skittles that <u>do not show the S</u>.
5. Remove those Skittles. They are now safe to eat. Please do so.

6. Repeat steps 3-5 until all the Skittles are gone. There may be times when your "shakes" do not produce any "blank" Skittles. That's okay, the number will just appear twice in your graph.

7. Plot the points onto the graph. You will need to determine the intervals for the vertical scale yourself. Draw a smooth curve/line through the points.

Shake #	Skittleium
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

# of SHAKES

(horizontal axis labeled: 1 2 3 4 5 6 7 8 9 10)