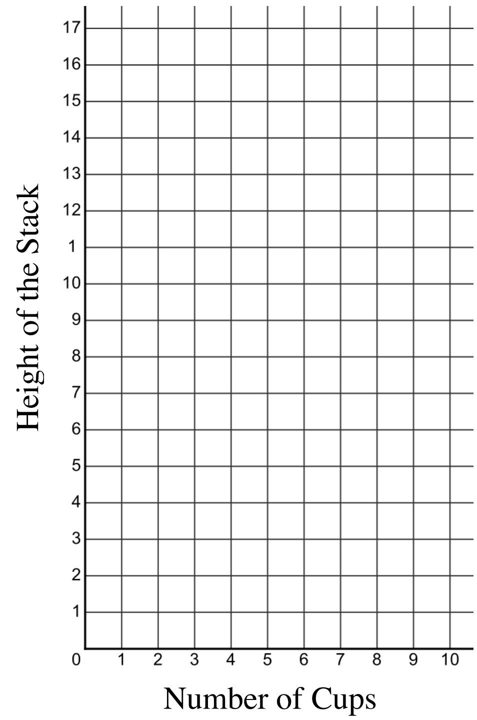
Name:____ Date:_____________ Period:________

Cups and Stacks

Task 1: Data Gathering and Analysis
Complete the table, and graph your data after measuring the height of 1, 2, and then 3 cups at your desk using centimeters. Extend patterns you see to fill in the heights for 4, 5 and 6 and to write an expression for the height of *c* cups.

c **(# of cups)**	***h*** **(height of stack)**
1	
2	
3	
4	
5	
6	
c	



Task 2: Model Creation and Explanation

1. How did you find the remaining heights without cups to measure? Explain your method and think of at least one other way to find the heights.

2. Explain the parameters of your expression. What is the meaning of each of the numbers?

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Task 3: Entering the Model into a Graphing Program

3. Open the Desmos graph at https://www.desmos.com/calculator/0n2ugyspgl
   a. Enter your data in the table in line 1.
   b. Enter your expression for the height of x cups in line 2. We will call this $h(x)$.
   c. Confirm that your expression makes a reasonable fit to your data. Make adjustments if needed.

Task 4: Using Graphs and Equations to Find Missing Values

4. The cup maker is considering packages of 14 cups. Enter $x = 14$ in line 3 of Desmos.

a. Show with a sketch how you can use the graph to find the height of 14 cups.

b. Show how you can use the function expression to find the height of 14 cups.

5. The cup maker has packaging that is 40 cm tall. Enter $y = 40$ in line 4 of Desmos.

a. Show with a sketch how you can use the graph to find how many cups will have a height of 40 cm.

b. Show how you can use the function expression to find how many cups will have a height of 40 cm.

Task 5: Comparing and Contrasting

6. Explain how questions 4 and 5 above are alike and different. Be sure to comment on both your use of the graphs and the algebraic expressions/equations.

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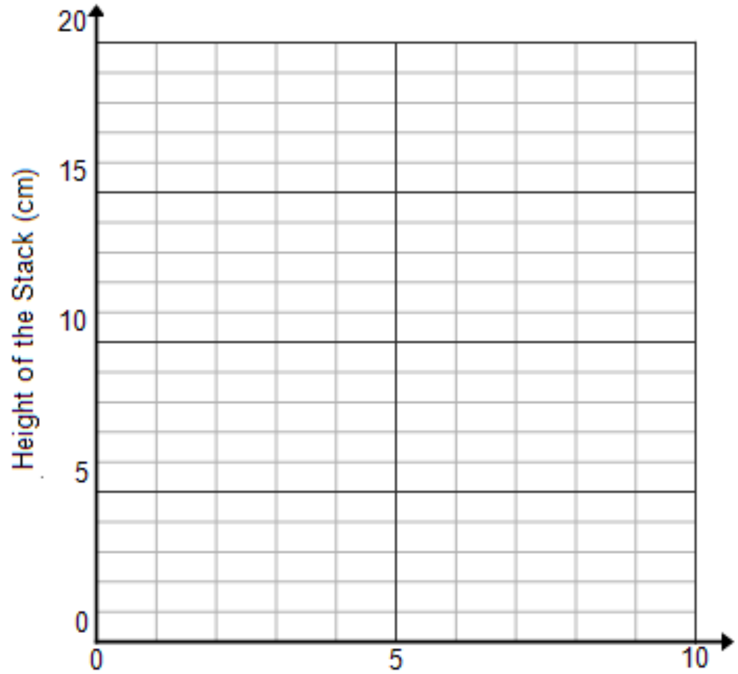
TASK 6: Practice

Isaiah collected data, but then spilled something on his paper and could not read the data that he wrote down. Use the points Isaiah still has to sketch a graph. Then use the graph to finish filling in the table and answer the questions.

Number of Cups	Height of the Stack (cm)
1	6
	7.5
3	9
4	
	18
10	19.5



7. How many cups were in the stack when the height was 18 cm? Explain how you found the solution.

____

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8. Isaiah was able to determine that his function, $h(c)$, is $h(c) = 1.5c + 4.5$. He wants to find the number of cups that will produce a stack that is 18cm tall.
   a) Write an equation that Isaiah could use to find the number of cups.

   b) How could Isaiah use his table to help him solve the equation?

   c) How could Isaiah use his graph to help him solve the equation?

Teacher Directions

Objective
Students will use stacks of cups to generate a linear equation and understand the concept of solving a linear equation both graphically and algebraically.

Materials

- Styrofoam Cups - 3 per group
- Rulers - 1 per student
- Access to Desmos (1 per team of students)

Activity Notes
Tasks 1 & 2:
Put students into groups of 4. Pass out the activity sheet, 3 cups and rulers to each of the groups. Model explicitly how to measure the height of one cup and clarify the portion of the cup that is called the "lip." See picture above.

Instruct students to complete the table and graph by measuring 1 cup (in *cm*), then 2 cups stacked, and finally, 3 cups stacked.

Note: Some students may start filling in the measure of one cup in the first row that has a zero. Be sure they start in the right spot.

Give groups time to consider means by which they can find the height of a stack of 4, 5 and 6 cups. Select ideas to share with the class. Look for students who might have borrowed 3 more cups (while this does not lead to the abstraction, it can be used to verify), those who extended the table, those who extended the graph and those who use the expression. Have a representative of each major strategy share and ask students questions to help them connect these representations.

Task 3:
Have students now open the Desmos graph using the web address listed and enter their data and verify that their expression matches the data. Note that as the cups are not always whole cm increments, the groups will need to discuss the fit of their line and make choices about the model that best fits. Have each group come list their expression on the board and lead a brief discussion comparing similarities and asking students the meaning of the coefficient (lip of the cup/ rate of change) and constant (height of cup without a lip/ initial value).

Task 4:
Have groups now follow the directions given in questions 4 & 5. Circulate to ask questions guiding students to connect the graphical representation to the algebraic solution. Ensure

Teacher Directions

that each group has a correct solution graphically and symbolically (either by observation or having a group come present).

Task 5:

Give students a few minutes to consider question 6 and record their ideas. Then use roundtable to have each person in a team of 4 share their ideas. Facilitate a class discussion, focusing on the major ideas of evaluating an expression algebraically (4b) vs. seeing this simplified answer on a graph (4a) and then solving an equation graphically (5b) vs. using a graph to solve (5a). Ask students what it means to “solve” and which method seemed easier to use in question 5.

Task 6:

This task now extends the concept of solving a linear equation graphically. Allow students 5-10 minutes to work on task 6 independently before discussing with a partner and then the class.