STACKING CUPS

STEM CATEGORY

Math

TOPIC

Linear Equations

OVERVIEW

Students will work in small groups to stack Solo® cups vs. Styrofoam cups to see how many of each it takes for the two stacks to be equal. Students will then derive a system of linear equations to model the scenario of the two stacks of cups. Students will then be asked to make predictions about how this concept applies to real-world scenarios (example: manufacturing, construction, architecture, etc.)

STEM LESSON FOCUS

Engineering Design Cycle	**21st Century Skills**
• Designing Solutions	• Critical Thinking

OBJECTIVES

Students will be able to:
Apply multiple representations of linear equations to **model** a given scenario; solve the system of equations to determine when the two linear expressions are equal.

MATERIALS

- Capture sheet
- Reflection sheet
- Solo® cups

STACKING CUPS

- Styrofoam cups
- Rulers

HAVE YOU EVER WONDERED…

How can systems of equations and inequalities model, and be used to solve, real-world problems?

MAKE CONNECTIONS!

How does this connect to students?	How does this connect to careers?	How does this connect to our world?
Learning to think algebraically will help you develop a strategic problem solving process when faced with important decisions.	**Computer Graphics Programmers** use linear algebra to create three-dimensional images. **Scientists** use linear equations to format and solve problems. This can help a chemist find the right combinations of chemicals for an experiment or a biologist to determine the size of a forest. **Architects** use linear equations to measure and cut materials. It can also help them estimate the materials needed for a project.	Problem solving and determining the best option in a given situation is an important life skill.

BLUEPRINT FOR DISCOVERY

1. Divide the students into small groups of 3 or 4. Hand out the stacking cups capture sheet, 3 of each type of cup, and a ruler to each small group. Help students to

understand the directions. Have students work in their small groups to complete the capture sheet.

2. While still in small groups, hand out the "Group 1: Equations" sheet to ½ of the groups and the "Group 2: Tables" sheet to the other ½ of the groups. Groups will work together to find the solution. Have small groups then share out to the whole class to see if all are in agreement. Discuss any differences.

3. Hand out the "Both Groups: Graph" sheet to all groups. Have groups work together and again share out their findings.

4. Guide students to complete the reflection paper.

5. If time, have students exchange word problems and solve their partner's word problem.

Take Action!
Find out how NASA used a system of equations to land a probe on the surface of the moon—https://www.ck12.org/algebra/applications-of-linear-systems/rwa/Shoot-for-the-Moon/?referrer=concept_details

NATIONAL STANDARDS

Mathematical Practice	F.BF.1—Write a function that describes the relationship between two quantities
Mathematical Practice	A.SSE.1—Interpret expressions that represent a quantity in terms of its context

STACKING CUPS CAPTURE SHEET

For this activity, you will be asked to investigate how the heights of Solo® cups and Styrofoam cups change when they are stacked one on top of the other. You will represent the Solo® cups and Styrofoam cups as either equations, tables, or graphs. You will use a system of equations to determine how many cups it will take for the two stacks to be the same height.

Investigation: You are only going to receive 3 of each kind of cup. Use your ruler (cm) to determine the pattern of growth for each stack of cups.

STACKING CUPS CAPTURE SHEET

Solo® Cup

1. What is the height of one Solo® cup (in cm)?

2. What is the height of two Solo® cups stacked together?

3. What is the height of three Solo® cups stacked together?

4. How much height are you adding to your stack each time you add another cup?

Styrofoam Cup

1. What is the height of one styrofoam cup (in cm)?

2. What is the height of two styrofoam cups stacked together?

3. What is the height of three styrofoam cups stacked together?

4. How much height are you adding to your stack each time you add another cup?

GROUP 1: EQUATIONS

Write a system of equations to represent the combined height of the cups when they are stacked together. Let x represent the number of cups in the stack; let y represent the total height in cm.

(Hint: Follow your growth pattern back to “0” to find the y-intercept.)

Equation #1 (Solo® Cups)	
Equation #2 (Styrofoam Cups)	

Solve the system of equations (elimination or substitution) to determine the number of cups in both stacks for the stacks to be the same height.

1. How many cups are in each stack when the stacks are the same height?

2. What is the height at which the stacks have an equal amount of cups?

BOTH GROUPS: GRAPH

Create a table for each type of cup to represent the combined height of the cups when they are stacked together. Let x represent the number of cups in the stack; let y represent the total height in cm.

Solo® Cups

x	y

Styrofoam Cups

x	y

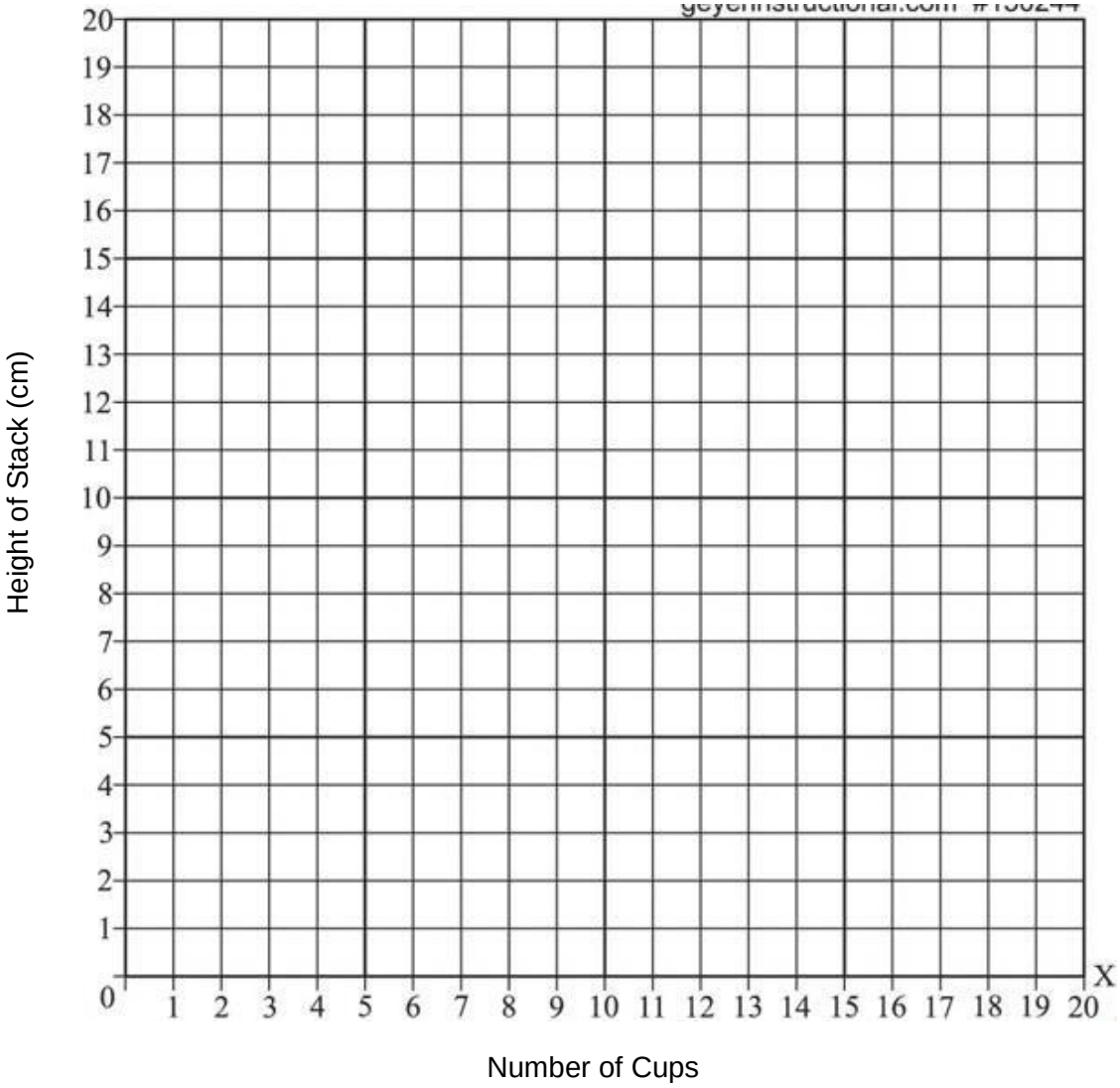
1. How many cups are in each stack when the stacks are the same height?

2. What is the height at which the stacks have an equal amount of cups?

BOTH GROUPS: GRAPH

Create a graph that represents the information from your tables or set of equations. Make sure that both types of cups are graphed. Label each line. Let *x* represent the number of cups in the stack; let *y* represent the total height in cm.

Heights of Solo® and Styrofoam Cups



1. How many cups are in each stack when the stacks are the same height?

2. What is the height at which the stacks have an equal amount of cups?

3. Did you get the same answers with your graph that you got with your tables or equations?

4. What do the y-intercepts represent?

5. What do the slopes represent?

6. Consider the following scenarios:

    - The You are an architect and have been hired to design two buildings of equal height using differing building materials, but one of the buildings sits on top of a hill. How tall will the buildings be if you use the same amount of each type of building material?

    - You need to get downtown and can't decide if you want to use Uber or Lyft. Uber charges a larger base fee but is cheaper per mile, whereas Lyft charges a smaller base fee but is more expensive per mile. At how many miles will the prices be the same?

    - You have been offered 2 different summer jobs, but both require training classes that cost money. One job's training class is more expensive, but you get paid more per hour. The other job's training class is less expensive, but you also get paid less per hour. How many hours would you have to work to net the same amount of money?

Select one of the scenarios above and write a word problem that can be solved using a system of linear equations. Solve it to make sure your problem makes sense.