MODELING CONSTRAINTS (SUMMER MONEY)

STEM CATEGORY

Math

TOPIC

Equations and Inequalities

OVERVIEW

Students will work in small groups to investigate constraints of starting a business (time, space, start-up cost, profit, etc.). Each group will be assigned a specific constraint. Small groups will then write a linear inequality and graph the inequality on a group capture sheet. Groups will then put all of the inequalities on a class graph to find when all constraints are met.

STEM LESSON FOCUS

Engineering Design Cycle	**21st Century Skills**
• Designing Solutions	• Collaboration

OBJECTIVES

Students will be able to:
Apply an authentic application to create, graph, and form conclusions about a system of linear inequalities.

MATERIALS

- Information about constraints
- Capture sheets with graph for each small group
- Class graph

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- Reflection questions

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?
Many students are interested in making money to gain independence. This lesson helps students explore things that need to be considered in order to start their own business.	**Professional bloggers** write material about various topics. They generate income through sharing their ideas and expertise. **Start-up CEOs** start companies that develop a product or service they believe is needed or in demand. They lead and manage their organization or business.	There are many people who try to become their own boss and start their own company but many are unsuccessful. Business owners need to be aware of the constraints of their industry and problem-solve to build a profitable and successful company.

BLUEPRINT FOR DISCOVERY

1. Hand out the “Summer Money” information sheet and have students read the given scenario and answer the “Think About” questions.
2. Divide students into 5 groups and distribute 1 constraint handout to each group. Students will work together to write and graph the inequality for their constraint.
3. Check student work to make sure the inequalities are graphed correctly. If they are correct, have a member of each group graph their inequality on the class graph.
4. Hand out the reflections sheet and have students complete the reflection questions. Guide students to share out their ideas for summer businesses and constraints for their business ideas.

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Take Action!
Small business ideas for teens—https://www.profitableventure.com/business-ideas-for-teens/
Business ideas for teen entrepreneurs—http://www.businessinsider.com/10-awesome-business-ideas-for-the-teen-entrepreneur-2011-2

NATIONAL STANDARDS

Mathematical Practice	N.Q.2—Define appropriate quantities for the purpose of descriptive modeling.
Technology Education	A.CED.2—Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

MODELING CONSTRAINTS (SUMMER MONEY)

SUMMER MONEY

Have you ever wanted to start your own business but you didn't know where to begin? There are many things to consider when starting your own business.

Brother and sister, John and Joelle, are trying to find a way to make money during summer vacation. When they overhear their aunt complaining about how difficult it is to find someone to care for her pets while she will be
away on a trip, John and Joelle know they have found the perfect solution.

John and Joelle decide to go into the pet-sitting business. They realize there are many things they need to consider, so they decide to make a list of constraints.

Space: They only have a limited amount of space in which to keep the cat and dog cages. (Assume only one animal per cage.)

Start-up Cost: They have some money saved up from last summer's business venture and decide to use this money to buy the cat and dog cages.

Feeding Time: They need to find time each day to feed each cat and dog.

Exercise Time: They need to find time each day to exercise each cat and dog.

Profit: They plan to charge their customers per cat and dog, but realize that they will also have to spend some money on food and supplies per cat and dog.

Think about:

- What does it mean to make a profit?
- What is a constraint?
- How many dogs and cats do you think you could take care of?
- What information would you need in order to make a decision about the number of cats and dogs you could take care of?

Group 1: Space Constraint

Cat cages will require 6 square feet of space, while dog cages require 24 square feet. John and Joelle have <u>up to</u> **360 square feet** available in the storage shed for cat and dog cages, while still leaving enough room to move around the cages.

Inequality

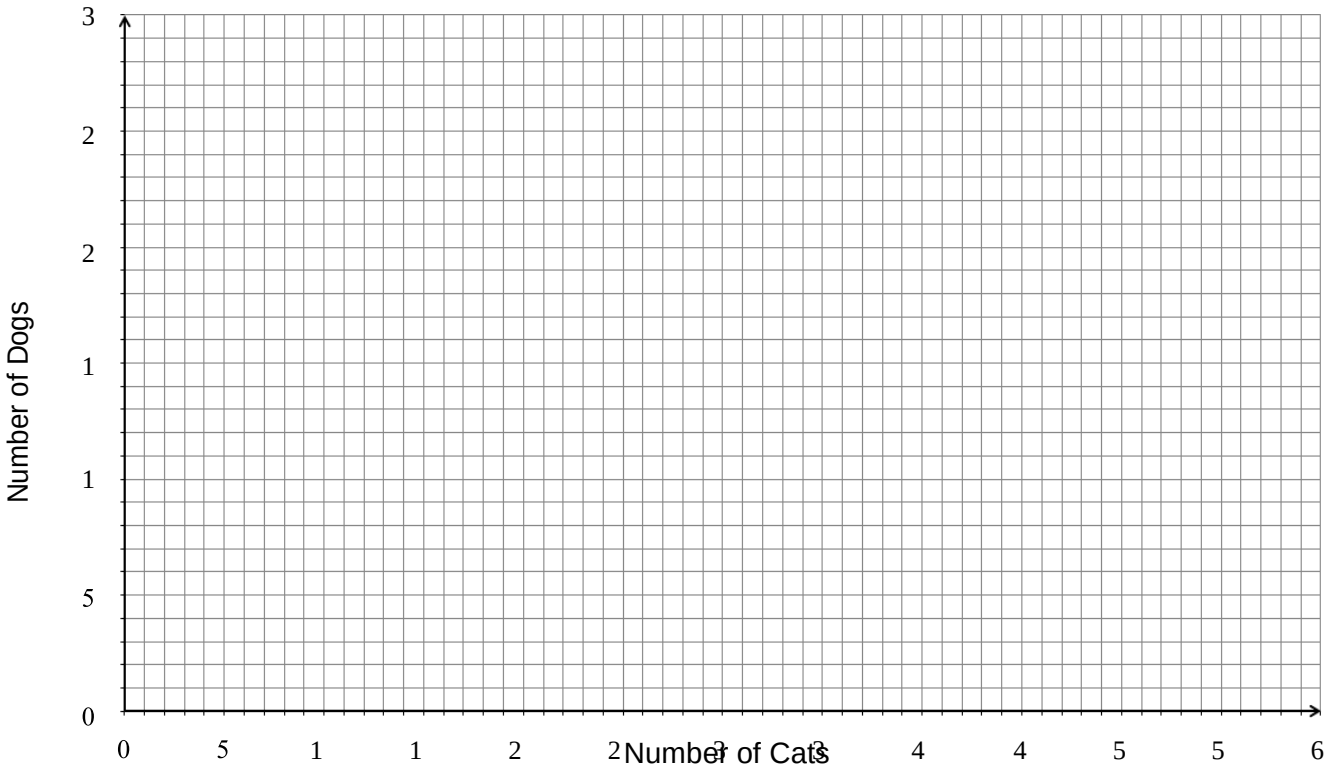
Write an inequality to represent the amount of cats and dogs John and Joelle have enough space to house.

Let x = number of cats
Let y = number of dogs

Solve for y

Put your inequality in slope/intercept form by solving for y.

Use your slope and y-intercept to **graph the inequality** below. Remember to shade the area that represents the number of possible cats and dogs for which John and Joelle have enough space.

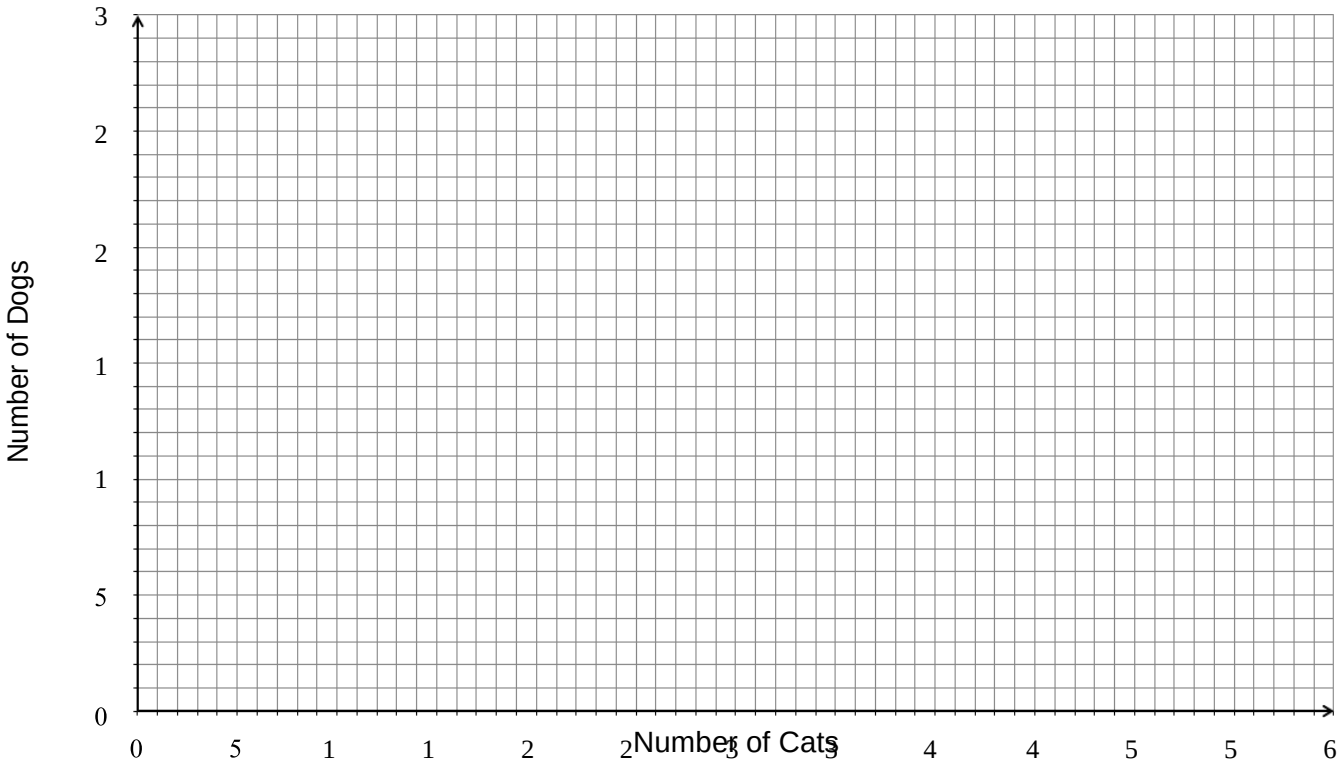


Group 2: Start-Up Cost Constraint

John and Joelle plan to invest up to the **$1280** they earned from their last business venture to purchase cat and cages. It will cost $32 for each cat cage and $80 for each dog cage.

Inequality	**Solve for y**
Write an inequality to represent the amount of cats and dogs John and Joelle have enough space to house. Let x = number of cats Let y = number of dogs	Put your inequality in slope/intercept form by solving for y.

Use your slope and y-intercept to **graph the inequality** below. Remember to shade the area that represents the number of possible cats and dogs for which John and Joelle have enough start-up money.

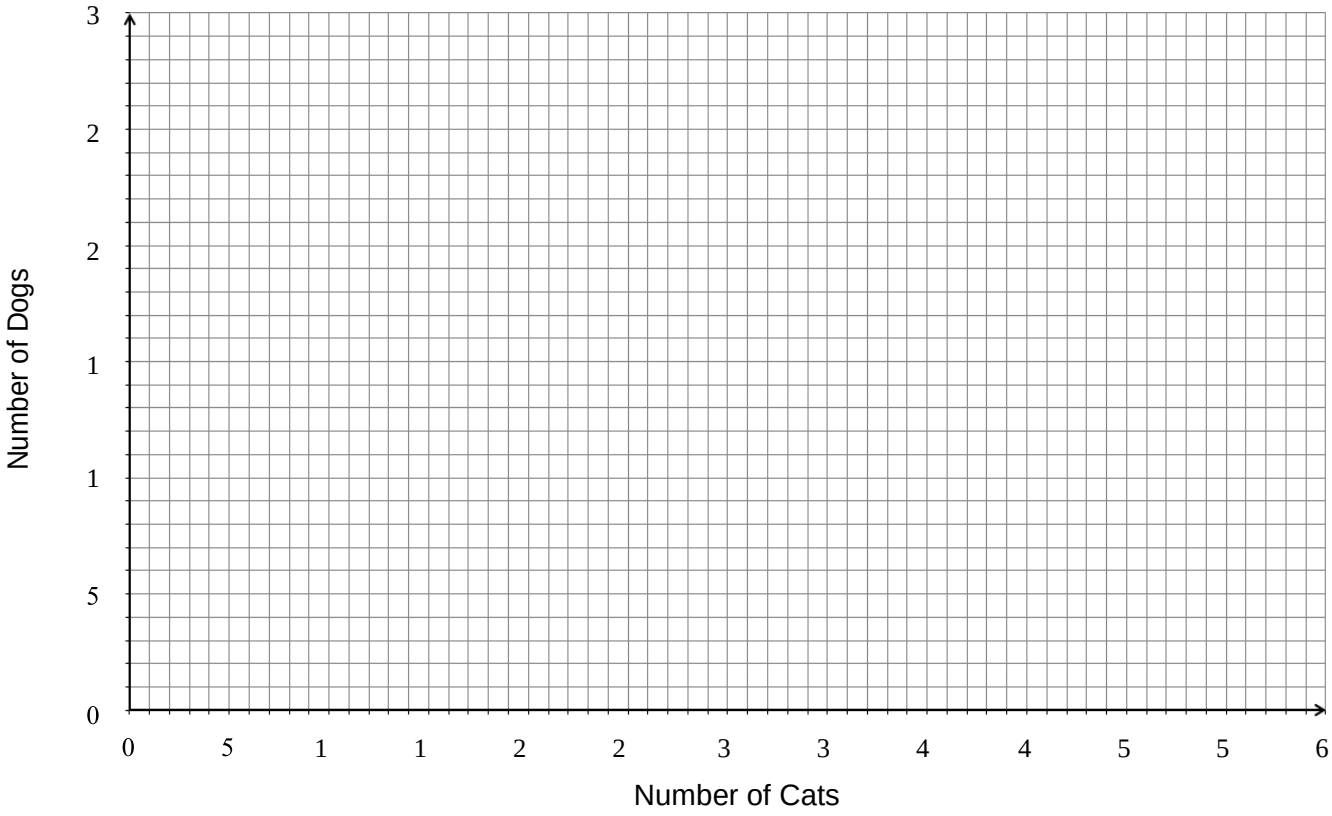


Group 3: Feeding Time Constraint

John and Joelle estimate the cats will require 12 minutes per day to feed and clean their litter boxes. Dogs will require 20 minutes per day to feed and walk. John and Joelle can spend up to 480 minutes each day feeding the pets.

Inequality	**Solve for y**
Write an inequality to represent the amount of cats and dogs John and Joelle have enough space to house. Let x = number of cats Let y = number of dogs	Put your inequality in slope/intercept form by solving for y.

Use your slope and y-intercept to **graph the inequality** below. Remember to shade the area that represents the number of possible cats and dogs for which John and Joelle have enough time to feed.

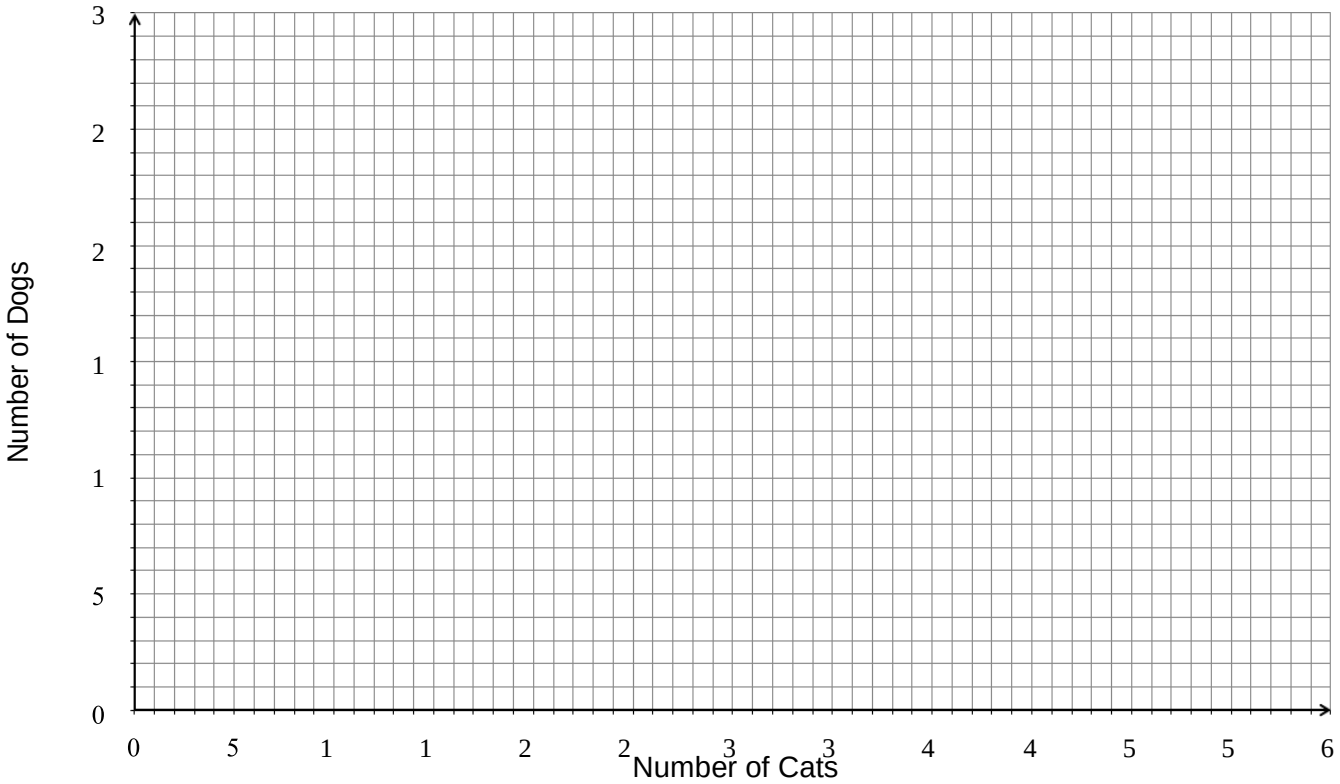


Group 4: Exercise Time Constraint

John and Joelle plan to spend 16 minutes each day playing with each cat, and 20 minutes each day running or throwing a ball with each dog. They can spend up to 480 minutes each day exercising each pet.

Inequality	**Solve for y**
Write an inequality to represent the amount of cats and dogs John and Joelle have enough space to house. Let x = number of cats Let y = number of dogs	Put your inequality in slope/intercept form by solving for y.

Use your slope and y-intercept to **graph the inequality** below. Remember to shade the area that represents the number of possible cats and dogs for which John and Joelle have enough time to exercise.

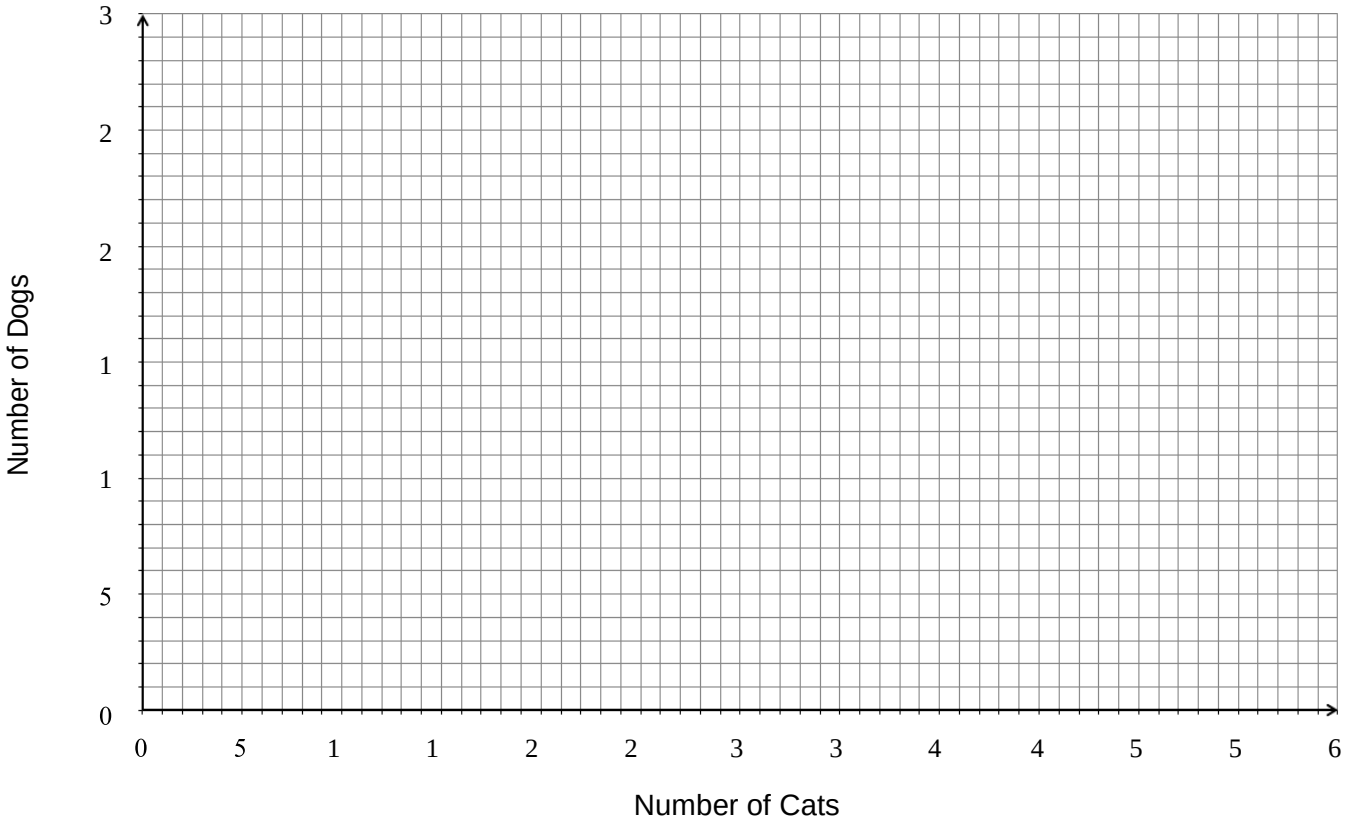


Group 5: Profit Constraint

John and Joelle want to make a profit of at least $180 per day. They believe they can make a profit of $6 per day for each cat and $16 per day for each dog.

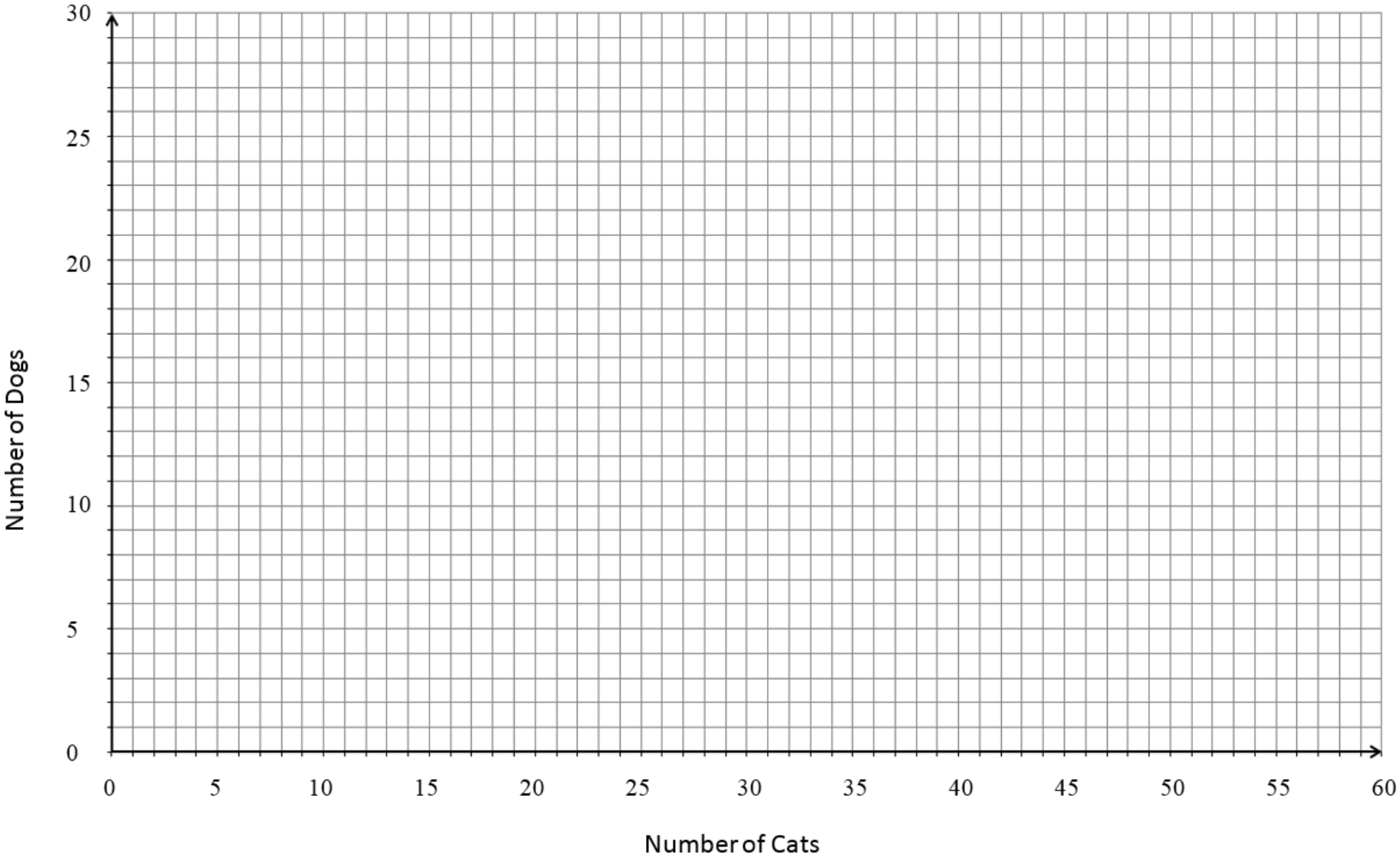
Inequality	**Solve for y**
Write an inequality to represent the amount of cats and dogs John and Joelle have enough space to house. Let x = number of cats Let y = number of dogs	Put your inequality in slope/intercept form by solving for y.

Use your slope and y-intercept to **graph the inequality** below. Remember to shade the area that represents the number of possible cats and dogs for which John and Joelle can board to reach their profit goal.



Class Graph

All groups should graph their inequalities on the graph below to find the area that represents where all the constraints are being met.



All Groups: Reflection

1. Find a combination of cats and dogs that would satisfy all the constraints.

2. What summer business do you think you could start in order to make a profit?

3. What kinds of constraints do you think you would have to consider?

4. What do you think is a reasonable daily profit for your business idea?

5. Why is it useful to combine all of the constraint inequalities on a single graph?

All Groups: Reflection

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