

# Wolves & Sheep

## Teacher Guide

This activity is for one or more players. It is suggested for students in grades 1 through 8.

The goal: to determine an arrangement of wolves and sheep on a square grid so that the sheep do not get “eaten” by the hungry wolves!

Challenges: Experiment with different arrangements of wolves and sheep on the same square grid to find the most number of sheep that can be placed on the grid without being eaten by the wolves.

## Materials

- **Student Handouts**
- **JRMF Handouts in English and in Spanish**
- **Video in English and in Spanish**
- **Manipulatives:**
  - Tokens -- can be made of anything as long as:
    - All of one type or color represent wolves (i.e., quarters)
    - All of another type or color represent sheep (i.e., pennies)
  - Square Gameboard Grids: (either drawn on paper, or use an existing chessboard, checkerboard, or other source for a grid -- examples can also be found at <https://mathcircles.org/>)
    - Start with a 4 by 4 grid, then move on to larger square grids.

# Categories

**Topics:** Prediction, Patterns, Logical & Mathematical Thinking

**Styles:** one or more player game

**Strategies:** Making choices and predicting outcomes

## **Mathematical Practices:**

- CCSS.MATH.PRACTICE MP1 -- Make sense of problems and persevere in solving them
- CCSS.MATH.PRACTICE MP2 -- Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE MP3 -- Construct viable arguments and critique the reasoning of others
- CCSS.MATH.PRACTICE MP4 -- Model with mathematics
- CCSS.MATH.PRACTICE MP5 -- Use appropriate tools strategically
- CCSS.MATH.PRACTICE MP6 -- Attend to precision
- CCSS.MATH.PRACTICE MP7 -- Look for and make use of structure
- CCSS.MATH.PRACTICE MP8 -- Look for and express regularity in repeated reasoning

## **Mathematical Standards:**

- CCSS.K.C.C. -- parts 1 - 7; Counting and Cardinality
- CCSS.1.O.A. -- parts 5 and 6; Operations & Alg Thinking
- CCSS.2.O.A. -- part 2; Operations & Alg Thinking
- CCSS.5.O.A. -- part 3; Operations & Alg Thinking
- CCSS.6.E.E. -- part 1 & 6; Expressions & Equations
- CCSS.7.E.E. -- Number Systems
- HS.A-SSE -- part 1; Seeing Structure in Expressions
- HS.A-CED -- part 1; Creating equations that describe numbers or relationships

# Facilitation Guide

## Purpose

As a facilitator, your goal is to make sure students understand the rules of the activity and have everything they need to get started and to have fun. We strongly discourage giving away answers! Let the students explore the mathematics themselves, and if they run into roadblocks, encourage their thinking by asking questions that support different methods of investigation. Suggest using scratch paper to write their thoughts as they work through the problems.

## Getting Started

Start by showing a 4 by 4 square grid and explain the rules and the goal of this activity:

### The Rules:

- Wolves and Sheep will be placed on the square grid. But the wolves are hungry! If a wolf has a straight path to a sheep then that sheep will get eaten!
- Show examples of straight paths:
  - If a wolf and a sheep are located on the same row
  - If a wolf and a sheep are located on the same column
  - If a wolf and a sheep are located on the same diagonal

### The Goal:

- To find places to put sheep on the grid so that they do not get eaten by a wolf! This means there isn't a straight path for a wolf to get to the sheep!
- Show examples of places where a sheep is "protected" from a wolf.

# Challenge Problems

## Challenge #1 -- using a 4 by 4 grid:

1. Find a way to place 2 wolves and 3 sheep on the same grid so that all the sheep are safe.
2. Remove one of the sheep and add a wolf. Now you have 3 wolves and 2 sheep. Try to place both the sheep on the grid so they are safe.
3. Now place only one wolf on the grid, and keep adding sheep to try to find the largest number of sheep that can be placed on the same grid without being eaten. Place the wolf in different locations -- the goal is to find the maximum number of sheep that can share the grid with only one wolf without being eaten!

## Challenge #2 -- using larger and larger square grids:

1. Use a 5 by 5 square grid and only one wolf on the grid. Keep adding sheep to try to find the largest number of sheep that can be placed on the same grid without being eaten. Place the wolf in different locations -- the goal is to find the maximum number of sheep that can share the grid with only one wolf without being eaten!
2. Repeat step 1 above, each time increasing the size of the grid; try a 6 by 6 grid, then a 7 by 7 grid; an 8 by 8 grid, and so on.

## Challenge #3: --- ask students the following:

1. Can you figure out the highest number of sheep that would be safe with one wolf on any square sized grid?
2. Is there a pattern, or can you find a mathematical expression for finding the largest amount of sheep with one wolf that could exist on a 100 by 100 square grid or larger?

**Challenge #4: --- 3 wolves and 5 sheep on a 5 by 5 square grid:**

1. Can you place 3 wolves and 5 sheep on the same square grid so that the sheep are safe?
2. How many possible solutions are there for this?
3. If you can find one solution, can you find another solution?
4. What is the total number of possibilities for solving this problem?

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