

# ROOK'S MOVE

## ACTIVITY GUIDE

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## Materials and Setup

Per table (assuming 3 pairs of students per table), you will need:

Per Table	Material Preparation	
3 x Chess board sets with 1 rook, 1 king, and 1 queen each		
3 copies of Instructions	1 page each	p. 7
3 copies of Tasks	1 page each	p. 8
1 copy of Table Sign	1 page <i>print on cardstock for sturdiness</i>	p. 9

Per Table	Purchasing Materials	
Chess boards	<a href="#">1 x vinyl chess board</a> for \$7.00	You will need to buy 3 of these, which will allow 3 groups of 2 students to play.
Chess pieces	<a href="#">chess pieces</a> \$1.00 each	Select 'Replacement Piece for 2.5" Plastic Analysis - \$1.00 REPL-ANLU'. Order 9 pieces. Indicate at the bottom of the webpage that you want 3 rooks, 3 kings, and 3 queens.
6 plastic sheet protectors	<a href="#">pack of 100</a> for \$8.14	These are recommended in order to protect the documents that students will be handling.





## Objective

The player who moves the rook to the bottom right square (h1) wins.

Rules:

1. Start with the rook on the top left square (a8).
2. Take turns moving the rook. On your turn, you can either move right or down, as many squares as you want.
3. You cannot move backwards.

## Materials

Each Rook's Move table should be prepped for 3 stations of two students.

Each station needs:

1. Chess board with 1 rook, 1 king, and 1 queen.
2. Rook's Move instructions.
3. Rook's Move tasks.

## How to Play

**We strongly encourage you to explore the activity yourself ahead of time.**

You can try our online version here: [jrmf.org/puzzle/rooks-move](http://jrmf.org/puzzle/rooks-move)

Introduce the activity without overexplaining it and without telling what strategies students might want to use. As much as possible, avoid giving away answers. Students should be encouraged to explore, experiment, and learn from their mistakes.

1. Demonstrate the rules by playing a game with the student (or pair of students).
2. Encourage them to explain their thinking out loud as they choose which move to make.
3. Have the student explore the game. Rook's Move is a 2-player game, so collaborating with a partner is preferred, but the game can also be played with an imaginary partner.

## Standards

1. Make sense of problems and persevere in solving them. CCSS.MP1
2. Construct viable arguments and critique the reasoning of others. CCSS.MP3
3. Model with mathematics. CCSS.MP4
4. Look for and make use of structure. CCSS.MP7



## Asking Good Questions

1. Ask questions about confidence.
  - a. When a student asks you “Is this right?”, instead of saying “yes” or “no” right away, ask them how confident they are in their answer. Here are some examples:
    - i. “Maybe. What do you think? How confident are you?”
    - ii. “On a scale of 1-5, how confident are you in your answer?”
  - b. If a student is not confident in their answer, follow up by asking “What would help you feel more confident in your answer?” or “Why do you not feel confident?” This helps you determine how best to help the student through their explorations.
2. Ask students about choices.
  - a. When a student is stuck or shows you a wrong answer, instead of jumping in and showing the student the correct answer, start by asking about the choices that the student made along the way. Here are some suggested steps to follow:
    - i. Start from the beginning.
    - ii. Ask students to show you what they’ve tried so far.
    - iii. When the student gets to a point where they have different choices, ask the student “What other choices can you make here?”
    - iv. Have the student make a different choice and try to solve the puzzle. This helps the student see that they have the power to make different choices during an activity, and they’ll start to do this on their own in the future.
    - v. If you’re familiar with the puzzle or a particular solution, stop the student only when a different choice will help them get to the solution. This will help them feel successful faster without you giving away too much of the answer.
3. Ask students about strategies.
  - a. If a student is getting into the activity and has been doing it for a while, ask the student if there are any strategies they’ve come up with to help them solve the puzzle or win the game.
  - b. Follow up by asking if they think their strategies will work for all puzzles and/or larger puzzles, more complex puzzles, etc. Have the student explore more complex puzzles to test out their strategies.
  - c. This is a great way to encourage a student to dive deeper into an activity and to start looking for patterns, structure, and proofs.
4. Activity specific questions.
  - a. Which squares do you like to see the rook in at the start of your turn? Which squares don’t you like seeing the rook in?
  - b. Can you explain who has the winning strategy based on the rook’s starting square?

## Answers

There are three related games in this activity: Rook's Move, King's Move, and Queen's Move. A good strategy for each of these games is to look at losing and winning positions.

### Losing Position

Assume that each player is playing perfectly. If you are in a **losing position**, then no matter what choice you make for your next move, you will eventually lose the game. Many students quickly see that g2 is a losing position in Rook's Move, but there are many more losing positions in this game as we'll see below.

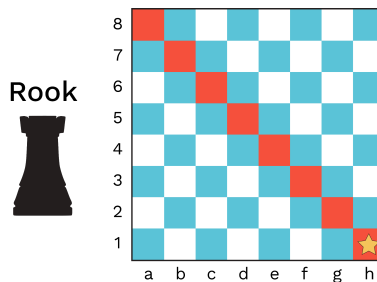
### Winning Position

If you are in a **winning position**, then there is at least one move you can make so that no matter what choice your opponent makes next, you will eventually win the game. Another way to say this is if you are in a **winning position**, then you are able to move the playing piece to a losing position on your next move.

### General Strategy

The general strategy for each of these games is: **Always move to a losing position on your turn, and you will eventually win the game.**

### Rook's Move Losing Positions (the orange squares)

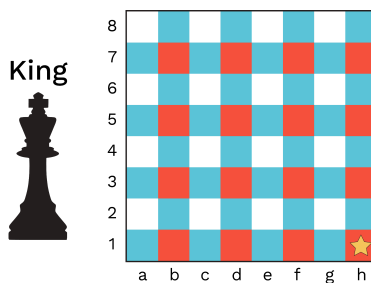


If you start on a8 (or another losing position), then the second player will always win, assuming both players are playing perfectly. If you start on b8 (or another position that is not a losing position), then the first player will always win.

One way to describe the strategy for Rook's Move: **Always move to the diagonal.**

Another way to describe the strategy for Rook's Move: **Go second and copy your opponent, but move in the other direction.** For example, if your opponent moves two squares down, then you should move two squares to the right. (this strategy only works if the game starts on a8 or another losing position).

### King's Move Losing Positions (the orange squares)

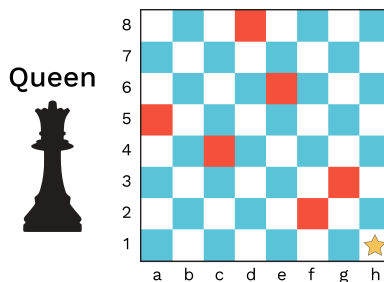


If you start on a8 (or another square that is not a losing position), then the first player will always win. Otherwise, the second player will always win.

One way to describe the strategy for King's Move: **Always move to a square that is an even distance away from the star both horizontally and vertically.** For example, b5 is 6 squares away from the star horizontally and 4 square away vertically. Because 6 and 4 are both even numbers, moving to b5 is a good move.

Another way to describe the strategy for King's Move: **Move to a losing square (like b7) on your first turn, and then copy your opponent.** For example, if your opponent moves one square down, then you should move one square down. (this strategy only works if the game starts on a8 or another square that is not already a losing position).

### Queen's Move Losing Positions (the orange squares)



Describing the strategy for this game is much harder. Students who come up with a good strategy for this game will usually talk about moving to a losing position on their turn. For example, students will quickly see that f2 and g3 are losing positions. Many students will come to the conclusion that starting on a7 or b8 doesn't make for a very interesting game since the first player can move to either f2 or g3.

There is a formula for finding all of the losing positions on a board of any size using the golden ratio. It isn't reasonable to expect students to come up with this on their own, and the formula itself is too advanced for most students. If you are interested in learning more about the general solution to Queen's Move and how the golden ratio is involved, we recommend researching Wythoff's Game.



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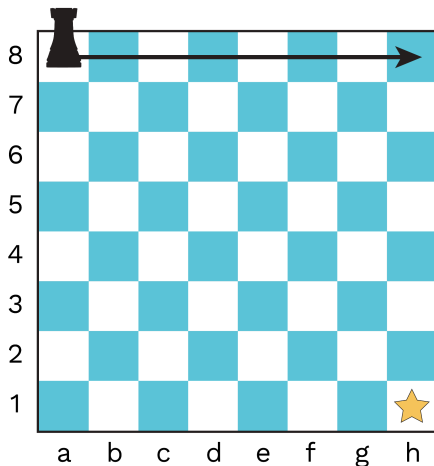
## Rook's Move Instructions

### Rules:

1. Place the rook on the top left square (a8).
2. Take turns moving the rook. On your turn, you can either move right or down, as many squares as you want.
3. You cannot move backwards.
4. The player who moves the rook to the bottom right square (h1) wins!

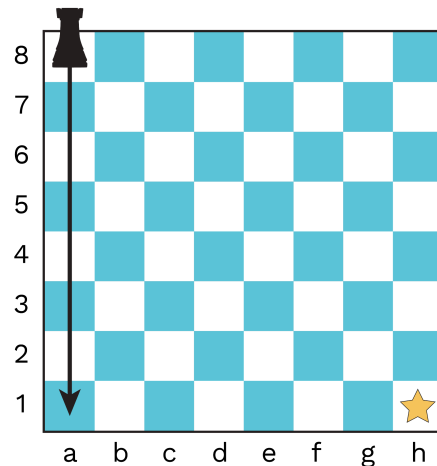
**On your turn, you can either...**

**Rook**



Move to the right as many squares as you want

**OR**



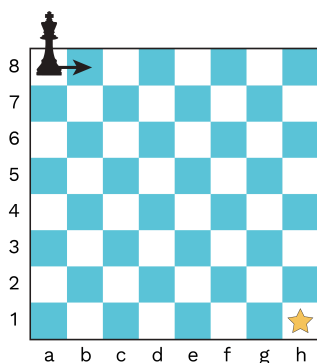
Move down as many squares as you want

## Rook's Move Tasks

1. Can you come up with a strategy that helps you win every time? Does it matter if you go first or second?
2. Start the rook on a different square. Does this change your strategy? Does it matter which square you start on?
3. Instead of playing with a rook, play with a king. In **King's Move**, on your turn you can either move one square right, down, or diagonally.

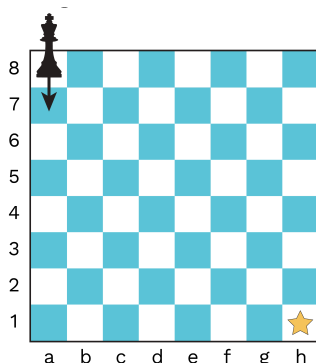
On your turn, you can either...

King



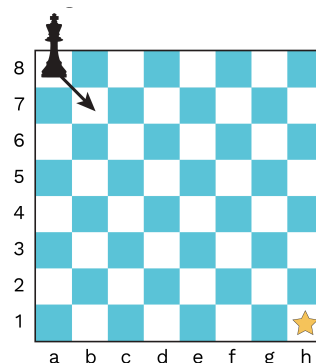
Move to the right one square

OR



Move down one square

OR

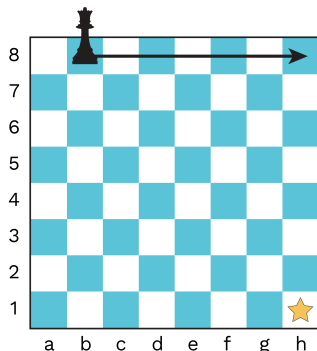


Move diagonally one square

4. Instead of playing with a king, play with a queen. In **Queen's Move**, on your turn you can either move right, down, or diagonally, as many squares as you want.

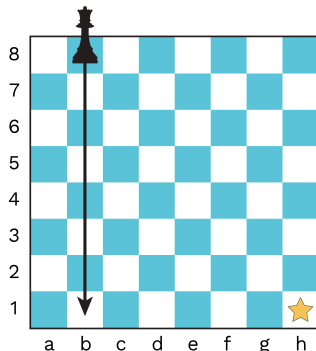
On your turn, you can either...

Queen



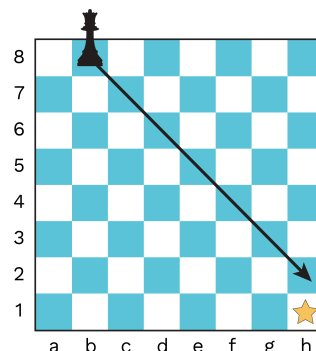
Move to the right as many squares as you want

OR



Move down as many squares as you want

OR

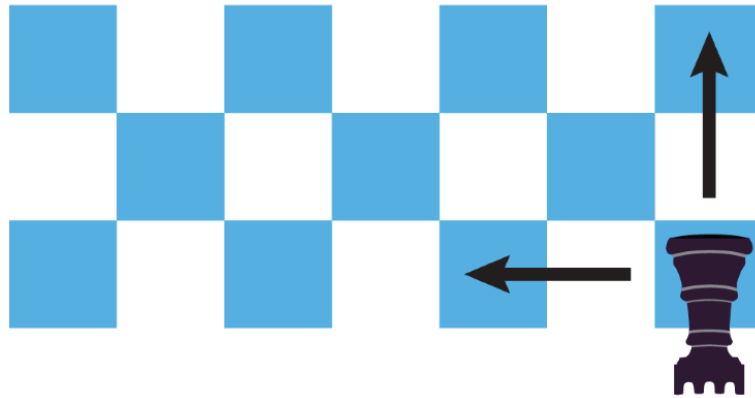


Move diagonally as many squares as you want

For Queen's Move, don't start on a8 (why not?). Instead, try starting on b8.



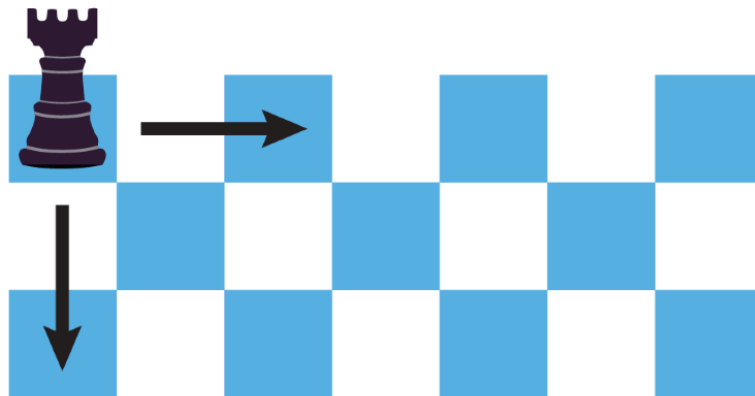
Play for free at  
[jrmf.org/puzzle/rooks-move](http://jrmf.org/puzzle/rooks-move)



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