

## Using Puzzles to Teach Problem Solving

# TEACHER'S GUIDE TO RUSH HOUR

Includes Rush Hour 2, 3, 4, Rush Hour Jr., Railroad Rush Hour and Safari Rush Hour

## BENEFITS

Rush Hour is a sliding piece puzzle that is an exciting way to teach elements of

- problem solving
- sequential thinking
- logical reasoning

The game is entirely self-directed, with 40 challenge cards that let students choose their level of difficulty. The six activities in this guide will help your students get more out of Rush Hour by reflecting on their experiences.

## ABOUT THE GAME

**Equipment.** Rush Hour includes a 6 by 6 playing board with an exit opening along on edge, a red escape car, 1 blocking cars, 4 blocking trucks, and 40 challenge cards. Variations of Rush Hour have slightly different pieces.



**How to Play** . Select a puzzle card and place the cars and trucks on the playing grid as shown in the illustration. The goal is to slide the red car (the escape vehicle) through the exit opening in the edge of the grid. To play, shift the cars and trucks up and down, left and right, until the path is cleared to slide the escape vehicle out the exit. You may not lift pieces off the grid. Pieces may only move forward and back, not sideways (except 2x2 pieces in Railroad Rush Hour and Safari Rush Hour).

**Challenge Cards** . Challenges are graded by difficulty: Beginner, Intermediate, Advanced and Expert. Some Rush Hour variations also include easier Junior and harder Grandmaster cards. The answer to each challenge is printed on the back of the card. Merely glancing at the back of a card will not give away the solution, since it takes work to read through a solution.

## Which version of Rush Hour to get?

There are several versions of Rush Hour. All activities in this guide work with all versions.

**Start with the basics** . For students age 8 or above, get the original Rush Hour. For students ages 6-8, get Rush Hour Jr. — same game, easier challenges.

**Then add on expansion packs** . For harder challenges, get Rush Hour 2, 3 or 4, each of which includes an extra car and 40 harder challenges.

**Or larger variations** . For variety, get Railroad or Safari Rush Hour, which use a larger 7 by 7 grid, and a new type of piece that moves in more directions.

**Related puzzles** . Other sliding block puzzles include the 15 puzzle. Lunar Lockout and Roadside Rescue. Other sequential thinking puzzles include Hoppers and Flip It.

## HISTORY OF RUSH HOUR

Rush Hour is a new variant of the traditional sliding block puzzle, which include puzzles where all pieces are the same size (below left), and puzzles where some pieces are larger rectangles or other shapes (below right).



The major innovation in Rush Hour is that each piece moves along only one direction, instead of moving both horizontally and vertically. This makes individual moves easier to understand, and sequences easier to visualize.

The idea for Rush Hour was independently invented by two different puzzle designers in the 1980s: Nob Yoshigahara in Japan, and Don Rubin in the USA. Nob focused his efforts on the small 6x6 board that became Rush Hour, while Don designed puzzles on larger boards.

Nob and his associates went on to design challenges for Rush Hour 2-4 and Rush Hour Jr, while American Scott Kim and Ukrainian Serhiy Grabarchuk invented Railroad and Safari Rush Hour, adding an additional square piece that could move both horizontally and vertically.

# INTRODUCING RUSH HOUR

Play the game, reflect on experience

**Try it** . Have students work through the puzzles on their own either individually or with a partner. Give each student a sheet to record their progress. You will find black-line masters on the next few pages. A few tips:

- Start with puzzle 1 to learn the rules.
- Work through puzzles in sequence, or skip around.
- Be sure to set up the opening position properly.
- If a puzzle is too hard, try an easier puzzle or remove some pieces and solve just part of the problem.
- If all else fails, dump the pieces out of the frame and start over, or play through the solution on the back.
- Ask students to write about their thought processes. Which puzzles did they find interesting and why?

**Reflect on experience** . As with all manipulatives, students will get more out of Rush Hour if they take time to reflect on their experiences. Ask students to write about:

- Explain the rules of the game in your own words. Show your rules to another student and see if they agree with your explanation. Can other people find loopholes in your rules?
- What problem solving strategies did you try? Which worked well and which did not?
- What did you do when you got stuck? Can you explain through words or diagram the strategies you tried in solving a particular puzzle? It may be easier to record your thoughts if you talk about what you are thinking as you work on a puzzle, and let your partner take notes.
- Write hints for a few puzzles that you found especially interesting. Try your hints on another student and see if they are helpful.
- What general advice would you give to other students trying to solve Rush Hour puzzles?

## Setting up a Puzzle Center

A collection of puzzle physical puzzles and puzzle books makes an excellent classroom resource. Here are a few tips on how to create puzzle centers.

- Choose sturdy puzzles with self-contained instructions and storage. Laminate instructions.
- Stations. Create several stations, each with several related puzzles. For instance you could have centers with sequential movement puzzles (Rush Hour, Lunar Lockout, Hoppers), packing puzzles (Shape by Shape, Brick by Brick), logic puzzles (Set, Mastermind), and number puzzles (Math Dice).
- As a supplemental activity. Have students work at the puzzle centers between periods or when they are done with in-class work.
- As a main activity. Divide students into small groups. At regular intervals, have groups rotate to the next center.

# Challenge cards for all versions of Rush Hour

Name: \_\_\_\_\_

<b>Railroad Rush Hour and Safari Rush Hour</b>		
include 10 extra cards labeled Junior 1 to Junior 10. Ignore these cards for Rush Hour 1–4 and Rush Hour Jr.		
<i>Puzzle</i>	<i>Solved?</i>	<i>Comments, hints</i>
Junior 1		
Junior 2		
Junior 3		
Junior 4		
Junior 5		
Junior 6		
Junior 7		
Junior 8		
Junior 9		
Junior 10		

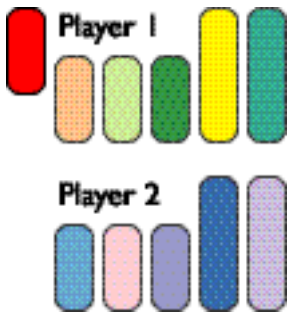
<i>Puzzle</i>	<i>Solved?</i>	<i>Comments, hints</i>
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2		
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4		
5		
6		
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8		
9		
10		

<i>Puzzle</i>	<i>Solved?</i>	<i>Comments, hints</i>
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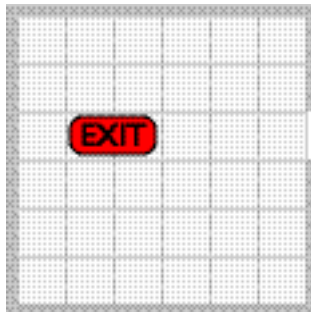
# PLAN AHEAD

## Game for 2 students on 1 board

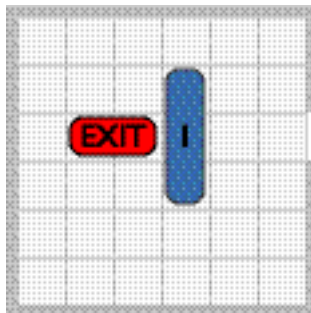
Rush Hour is primarily an exercise in sequential thinking. The further ahead you can think, the better you can solve puzzles. After playing Rush Hour for a while you will find that your ability to see a series of moves in advance improves. Here is an exciting game for two players on one Rush Hour board that stretches your ability to plan ahead.



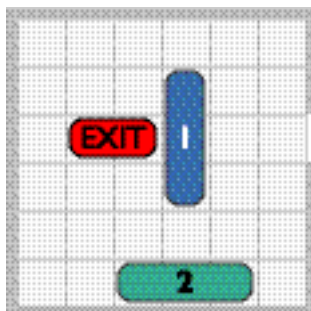
Each player receives the same assortment of 5 pieces (e.g. 3 cars and 2 trucks). Player 1 also gets the red escape car. Tip: to make the game harder, increase the number of pieces each player gets.



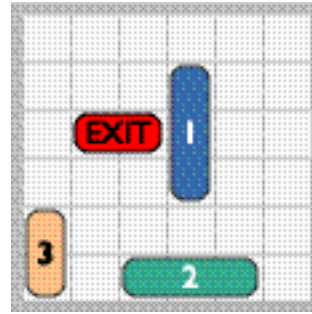
On the first move, player 1 places the escape car in the escape row, at least one square away from the exit, so there is room to block it.



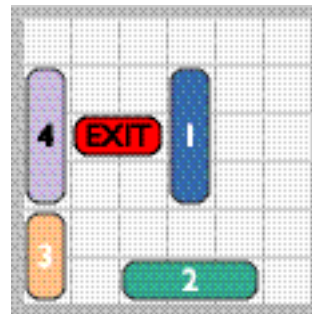
Then players take turns placing pieces, trying to keep the puzzle solvable. Here player 2 adds a blue piece to block the red piece exiting. Note that to unblock the red car, the blue piece must slide all the way to the bottom.



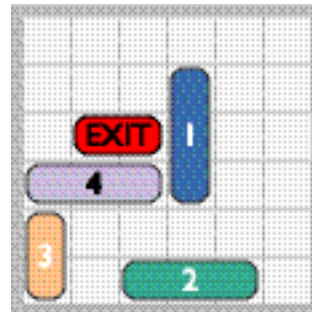
Player 1 adds a green piece, blocking the blue piece from to the bottom. Both pieces must move before the red car can exit. Tip: place pieces where they block other pieces, making the solution harder to visualize.



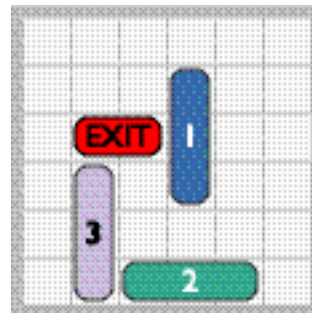
Player 2 adds an orange piece, blocking the green piece from sliding all the way left.



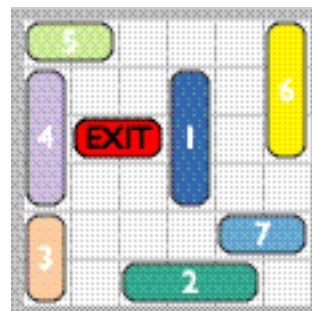
A player can challenge a move by saying "Solve It!" The other player must then solve the puzzle in one minute (or other time limit). Solving the puzzle wins the game; not solving loses. If there are no challenges, the final player must solve the puzzle.



Here is a trickier alternative to the last move. Can you visualize the solution? Hint: the blue piece must move twice.



Here is a position that should be challenge. Can you explain why this puzzle cannot be solved? Answer: no matter how the four pieces move, they block each other in a circle: X blocks 3 blocks 2 blocks 1 blocks X.



Here is challenge card 1 from Rush Hour. Can you visualize the complete solution? Hint: the yellow and light blue pieces introduce a new complication.

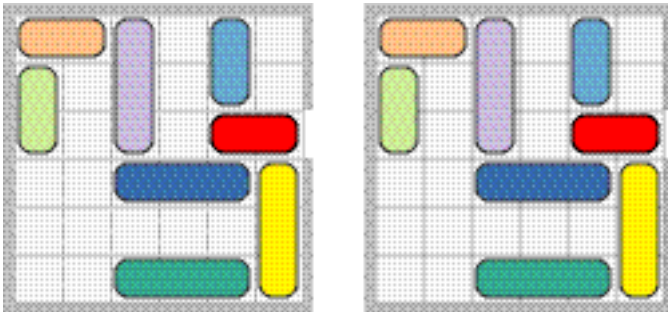
# SCRAMBLE

## Game for 2 students on 2 boards

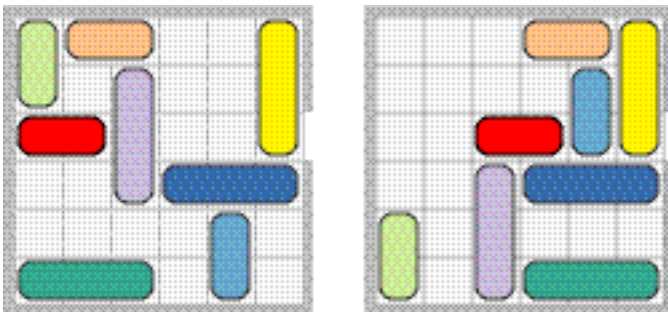
This game involves students in creating their own Rush Hour challenges.

Two players each start with identical boards and pieces. You can use any version of Rush Hour — Rush Hour, Rush Hour Jr., Railroad Rush Hour or Safari Rush Hour — as long as both boards are identical.

1. Setup. Start by placing the escape vehicle at the exit on one board. Ignore the other board for the moment. The two players take turns placing additional pieces on the board until it is fairly full, say 8 to 12 pieces. Copy the position on the other board, so both boards have the same opening position. For instance, the opening positions might be:



2. Scramble. From these identical positions, both players slide pieces around on their boards, trying to make a puzzle that is as hard as possible to solve. After one minute (or other time limit) players freeze their positions. For instance, the two players might scramble their boards like this:



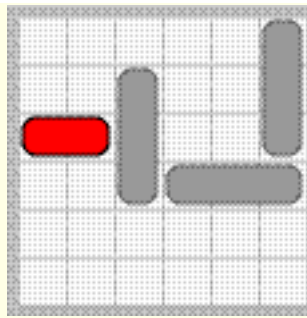
3. Race. Players exchange boards. Both players, starting at the same time, try to solve the puzzle they were given. The first player to solve their puzzle wins.

Note that both puzzles are guaranteed to be solvable, since they were constructed by scrambling a legal ending position. Working backwards this way works in Rush Hour because moves are reversible.

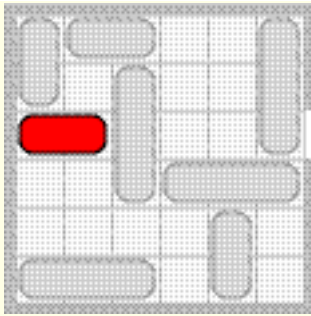
At the end of the game ask students to describe to the other student what they were thinking when they set the pieces as they did. This way students learn to verbalize their thinking, and learn from other students.

# Strategy I: WORKING BACKWARDS

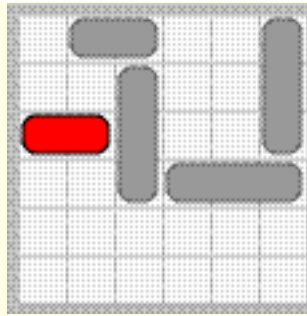
Here is a strategy you can show students who want to improve their game. In Rush Hour, as in life, we are often faced with situations where it is hard to figure out what to do next, but it is easy to identify what must happen last. In these cases working backwards is a good strategy. Try this technique to help you solve Rush Hour puzzles.



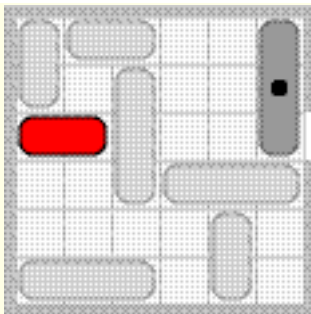
Now set up a starting position with just the cars highlighted in your diagram. See if you can solve this problem.



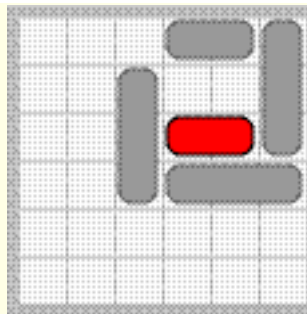
Choose a challenge card that you have not yet solved. Sketch a diagram on paper of the starting position. Here is the starting position from challenge 11 from Rush Hour.



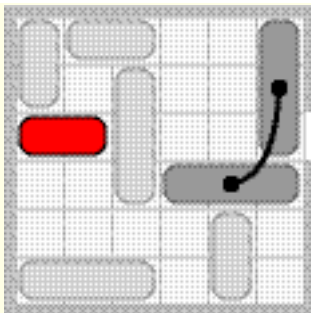
If the puzzle is too hard, remove pieces at the end of your chain of reasoning. If it is too easy, add pieces to the end of the chain. Here we added one more piece.



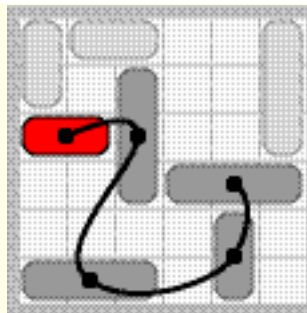
Highlight the last piece that must move before the escape vehicle can exit the board.



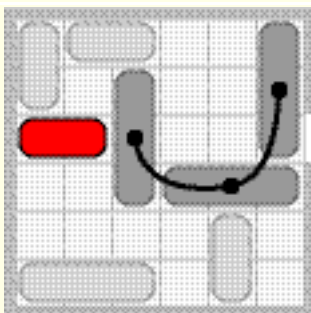
By solving this puzzle we learn that the escape car must first get to this intermediate position before it can exit the board.



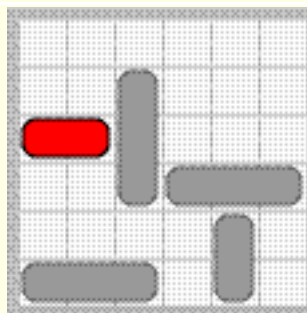
Draw a line from the last piece to the piece (or pieces) that must move in order for the last piece to move.



You can also work forwards. Draw a line from the escape vehicle to the piece (or pieces) that blocks its escape. Then draw a line from that piece to pieces that block that piece's movement. Continue until you reach a loop or a dead end.



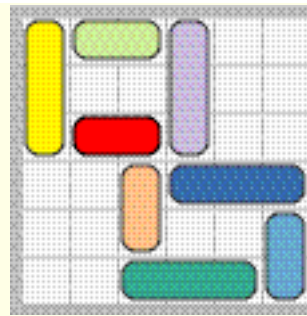
Then draw a line from that previous piece to whatever piece (or pieces) must move for the previous piece to move. Continue drawing lines to blocking pieces several steps further if you can.



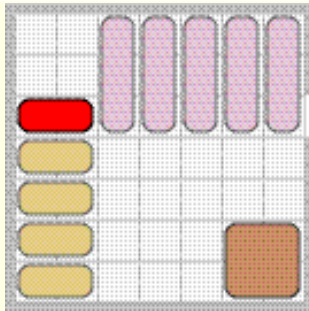
Then try solving the puzzle that uses just the highlighted pieces. How can your insights from solving this subproblem help you solve the original problem?

## Strategy 2: FIND THE KEY MOVE

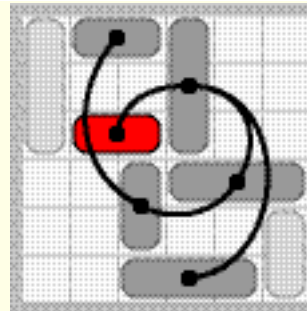
Some puzzles require a flash of insight, a key move that makes everything else fall into place. Ask your students if they can find the key move in each of the following Rush Hour puzzles by setting up the opening position and asking the **key question**. Then encourage students to ask their own questions about other Rush Hour positions.



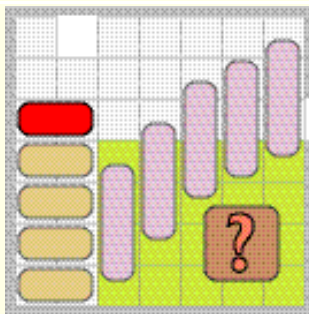
Here is challenge 11 from Rush Hour. The key question is **where must pieces be when the lavender 1x3 piece blocking the escape vehicle slides all the way down to the bottom?**



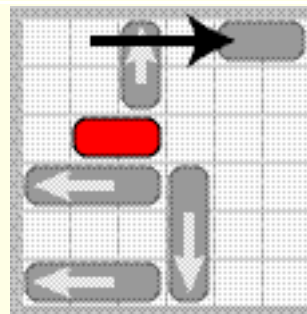
Here is challenge 20 from Railroad Rush Hour. The key question is: **where does the square piece need to be?** Ponder this question before reading further. Remember, the square piece can move both horizontally and vertically.



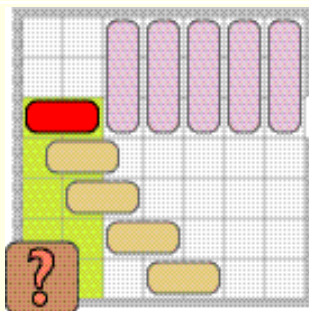
To make room for the lavender piece (a) to slide all the way down, the two horizontal 1x3 pieces (b) must be all the way left, which forces a vertical 1x2 piece (c) up. But then the 1x2 piece at top is forced right.



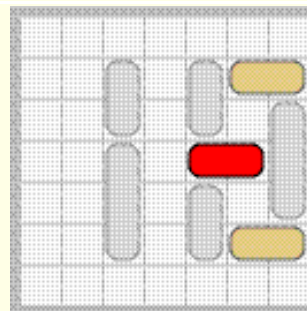
If the square piece is in any of the right 5 columns it prevents at least some of the trucks from sliding all the way down to unblock the escape row.



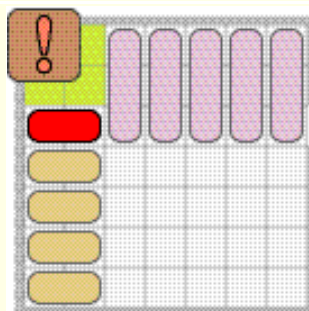
Here is the key position, with the key move. It occurs halfway through the solution, and is the only time this piece moves. Knowing that this move is important will help you stay oriented while you work out the solution.



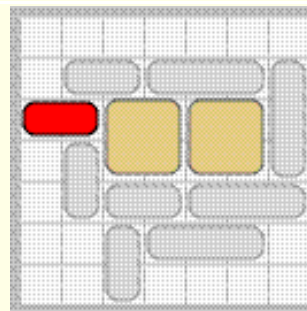
If the square piece is anywhere in the bottom four rows of the first two columns then it forces at least some cars to the right, which in turn blocks trucks from sliding all the way down to unblock the escape row.



Here is Junior challenge 8 from Railroad Rush Hour. The key question is **where must the horizontal (orange) cars be for the vertical piece blocking the exit to move out of the way?** Answer: one of the orange cars must be far left.



Therefore the only place the square piece can be is in the upper left corner. Once you realize this insight, the puzzle is easy to solve.



Here is challenge 21 from Railroad Rush Hour. The key question is **where must the (orange) square pieces be for the escape vehicle to escape?** Answer: both must move down, below the escape row. Above looks like it might work, but doesn't.

# CREATE YOUR OWN

An open-ended creative activity

Problem posing is an important part of problem solving, since in real life there is no teacher to tell you which problems to solve. In the activities *Plan Ahead* and *Scramble* students construct their own puzzles. In this activity we explore puzzle creation in more depth.

**Create your own** . Invent your own Rush Hour puzzle, using any version of Rush Hour. Draw the opening position on a sheet of paper (see blackline masters on following pages). Label the pieces with letters (X is always the escape vehicle) and write down a solution.

Describe how you constructed the puzzle, and the criteria you used to judge whether the puzzle was good.

Give your puzzles to at least one other student and watch them try to solve it. Was it easier or harder than you expected? Where did the other student get stuck? Did the other student find a better solution than yours? Based on testing results, find a way to improve or change the puzzle.

**Create sequences** . Instead of creating just one puzzle, create a sequence of three puzzles: easy, medium and hard. If possible find a way to link the puzzles thematically. For instance they might use similar pieces, or hinge on the same strategy. Test your puzzle on at least one other student and see if they agree whether your assessment of which puzzle is easy, medium and hard.

**Design criteria** . List at least five criteria for evaluating Rush Hour puzzles. Include both and aesthetic criteria. Judge your own puzzles using the criteria and see if there are ways to improve them. For instance:

- Requires at least 10 moves
- Opening position forms a pleasing pattern

**Getting ideas** . Suppose you were given the task of designing 40 new Rush Hour puzzles. How would you go about it? Here are some of the ways puzzle designer Scott Kim invented puzzles for Railroad Rush Hour:

- Form a attractive pattern, then try to solve it.
- Design a hard puzzle, then create easier puzzles that lead up to it.
- Use as many or few pieces as possible.
- Figure out an unlikely move, then build a puzzle that requires it.

**Change the appearance** . What other objects would be nice to slide around instead of cars? Can you write a story in which the main character has to solve a problem in a natural setting that is equivalent to Rush Hour? For instance, the main character might have to get a car out of a crowded parking lot. Can you think of other story settings for Rush Hour?

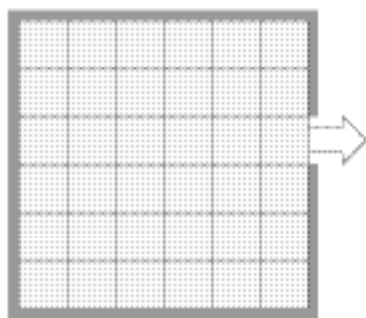
**Change the rules** . Invent a new game based on Rush Hour. How could you change the board, the piece shapes, the way pieces move, or the goal of the game?

**Programming** . Suppose you wrote a program to solve Rush Hour puzzles. Can you describe how it would work? How could you be sure you had found the shortest solution? How would you write a program to construct Rush Hour puzzles?

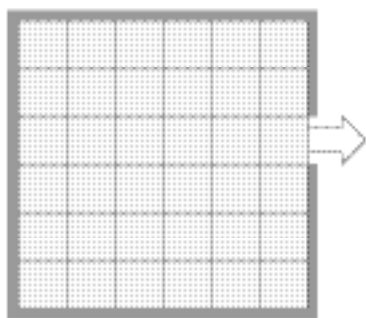


**Rush Hour Challenges on a 6 by 6 board**

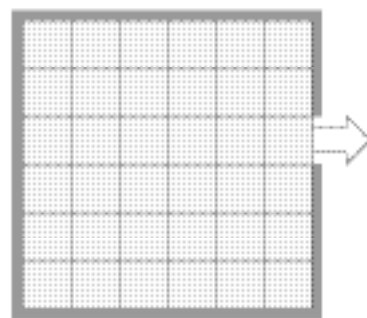
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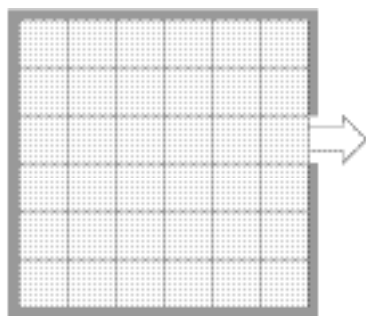
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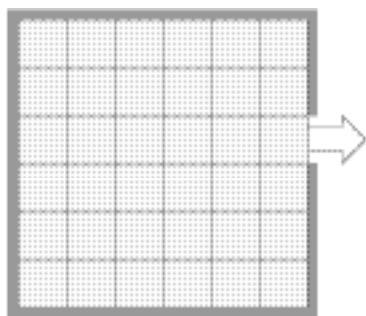
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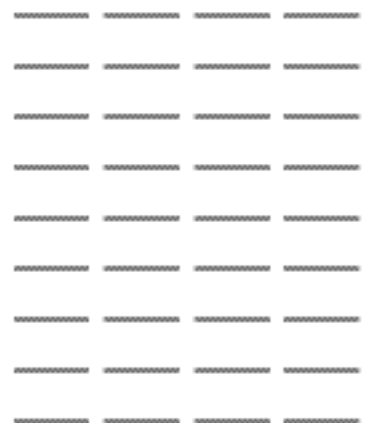
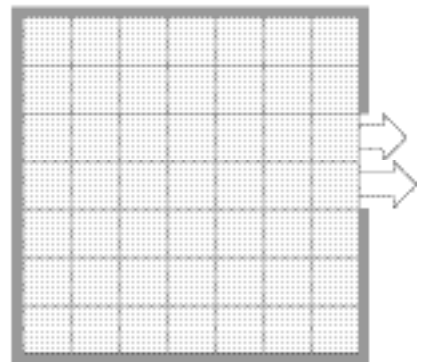
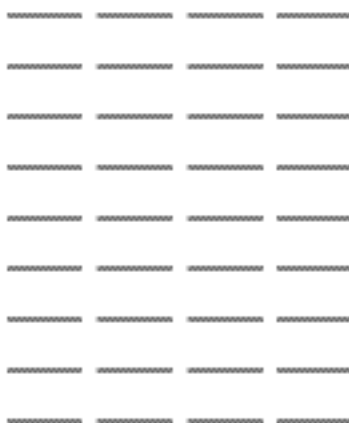
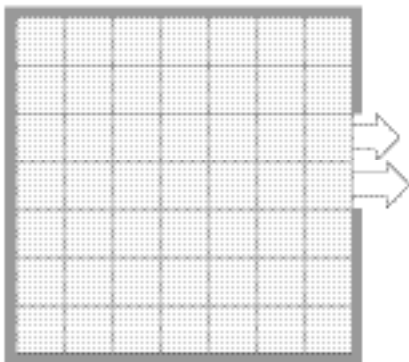
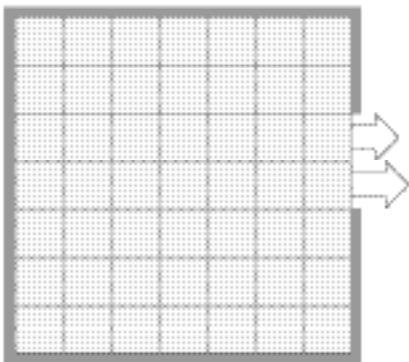
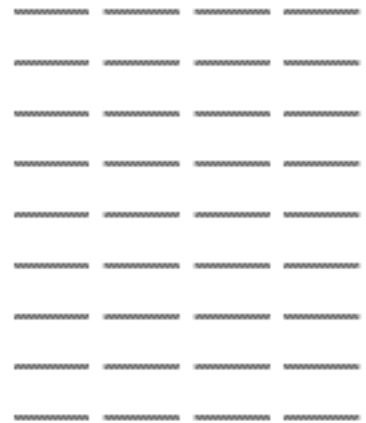
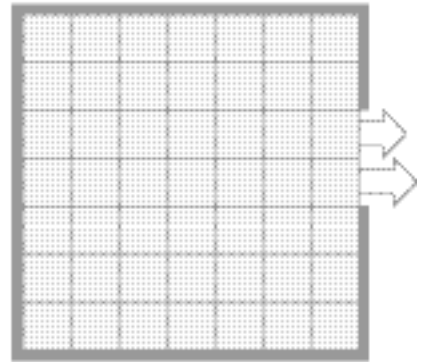
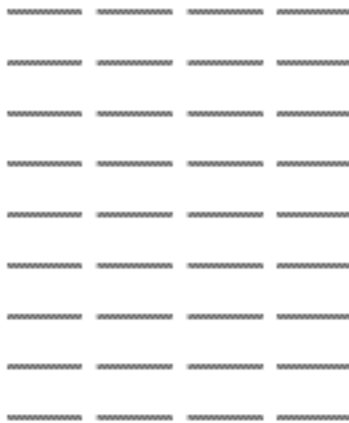
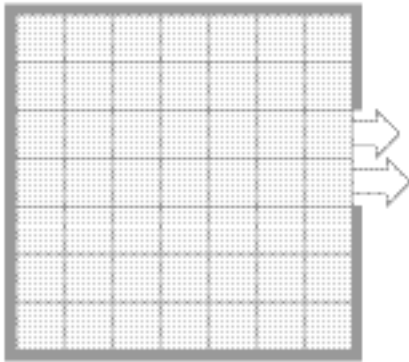
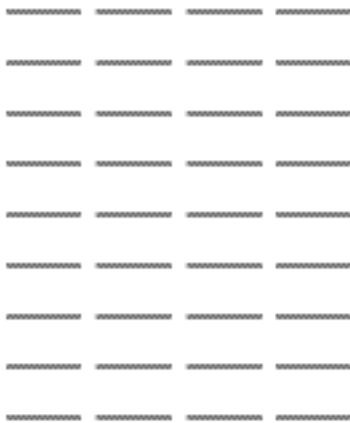
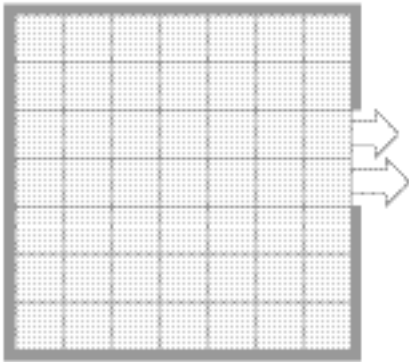
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# LEARNING FROM RUSH HOUR

Big open-ended discussion questions

**Strategic thinking** . Play other sequential thinking puzzles and games, and compare the strategies you use to the ones in Rush Hour.

- Lunar Lockout. Compare Rush Hour and Lunar Lockout. What is different and what is the same? Why are Lunar Lockout puzzles so much shorter than Rush Hour puzzles of the same difficulty? How well do Rush Hour strategies apply to Lunar Lockout? Can you invent a new game that blends rules from both games?
- Other puzzles. Compare Rush Hour with other sliding piece puzzles (such as the 15 puzzle), and other sequential thinking puzzles (such as Hoppers or Fliplt). What is different and what is the same? How well do Rush Hour strategies apply to these other puzzles? Some of these games have reversible moves, some do not. How does that make a difference?
- Game strategy. Try applying Rush Hour strategies apply to games of strategy such as chess or checkers. How is playing chess similar to or different from solving a Rush Hour puzzle?

**Apply strategies to other situations** . Applying what you have learned to other situations is one of the best ways to make it your own.

- Mathematics. Discuss ways that solving puzzles like Rush Hour is similar to solving problems in mathematics, such as algebra or word problems.
- Writing. Mysteries, with their complicated tangled plots, are much like puzzles. Read a mystery novel and diagram who knows what at each point in the story. How do you think mystery writers plot their plots?
- Planning a trip. When you plan a trip, you often have to work backwards in order to make sure you can get everything done before you leave. How else do Rush Hour strategies apply to everyday planning?

**Classifying puzzles** . These questions further develop a critical understanding of problem solving skills.

- Compare puzzles. Which puzzles are best for developing which types of problem solving skills?
- Classify puzzles using Venn diagrams. List 20 types of puzzles. Decide on 3 or 4 attributes for classifying puzzles. Sort the puzzles into categories using a Venn diagram. Find existing types of puzzles or invent new types of puzzles for categories with no members.