



Julia Robinson
(1919 - 1985)

A Mathematician's Travel Kit



In this bag, you'll find 16 two-color counters, 24 matchsticks, a foldable chessboard, and these instructions for 9 different puzzles and games. All of these activities need only the materials provided here, allowing the on-the-go mathematician to turn any environment into their own mathematical playground.

Happy mathing!

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Activity #1: 9-Dots

Materials:

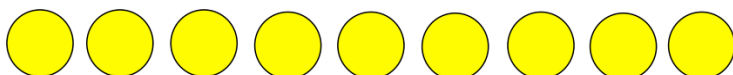
- 9 two-color counters

Objective:

Flip over the last dot. Whoever does this wins!

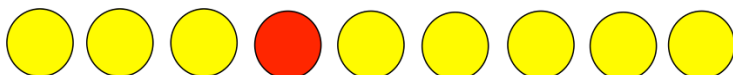
Set-Up:

1. Make a line of 9 dots so that all the dots are yellow.

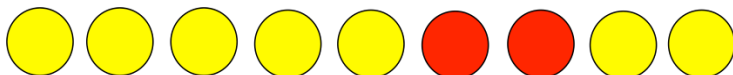


Rules:

1. Players take turns either flipping over 1 dot or flipping over 2 dots that are right next to each other.
2. Only yellow dots can be flipped over.



OR



3. Two yellow dots that are not next to each other cannot be flipped over on the same turn.

Variants:

1. Play the same game with a different number of starting dots.
2. Play the same game, but the player who flips over the last dot loses instead of wins.
3. Play the same game, but in two dimensions. Create a grid of dots (e.g. 3×4). Players can either flip over 1 dot or 2 dots that are horizontally or vertically right next to each other.



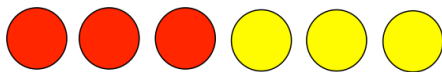
Activity #2: Goats and Sheep

Materials:

- 6 two-color counters
- 10 matchsticks

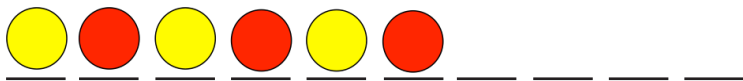
Objective:

Get all of the sheep (yellow) to be on the right and all of the goats (red) to be on the left, like below:



Set-Up:

1. Place 10 matchsticks horizontally to represent 10 animal pens.
2. Place sheep (yellow) and goats (red) into these animal pens like below:



Rules:

1. Animals must be moved into empty pens.
2. Animals are sociable! Animals must be moved two at a time.
3. Two animals that are moved together must start right next to each other and end up right next to each other.
4. Animals cannot reorder themselves while being moved.

Challenges:

1. Solve the puzzle above in 6 moves.
2. Solve the puzzle above in only 3 moves.
3. Solve the same puzzle with 12 pens, 4 goats, and 4 sheep.
4. Can you come up with a procedure that works for any number of goats and sheep?



Activity #3: Chomp

Materials:

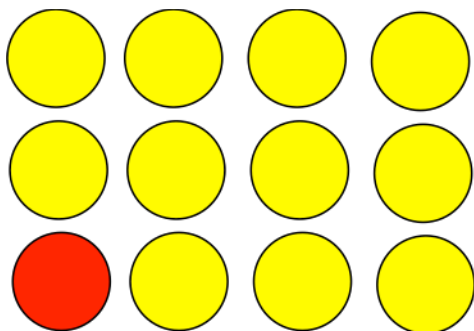
- 12 two-color counters

Objective:

Don't eat the poisoned chocolate (red). Whoever eats it *loses*!

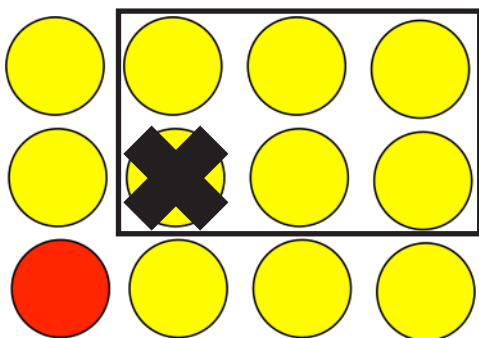
Set-Up:

1. Set up a 3 x 4 grid of yellow dots.
2. Flip the bottom left dot to the red side, like below:



Rules:

1. Players take turns chomping chocolate pieces.
2. To do this, a player eats (removes) any piece of chocolate, and then eats all of the pieces above and to the right of it.
3. For example, if a player eats the piece with an X on it, the player must eat all of the pieces in the rectangle:



Variants:

1. Play the same game with a different starting grid (e.g. 3×3 , 2×5 , 4×4).
2. Play the same game, but make more pieces of chocolate poisoned by flipping them from the yellow to the red side. After all pieces of chocolate are eaten, whoever eats the *most* poisoned pieces loses.



Activity #4: Making Squares

Materials:

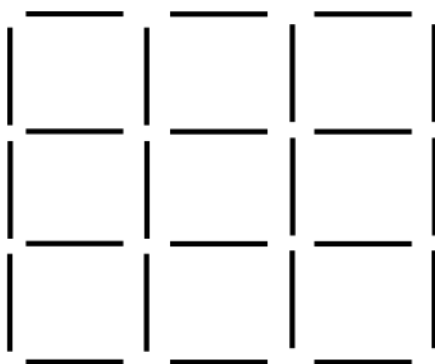
- 24 matchsticks.

Objective:

Create squares by removing matchsticks.

Set-Up:

Create a 3 x 3 grid using matchsticks, like below:



Rules:

1. Remove 4 matchsticks to make 5 squares.
2. Remove 6 matchsticks to make 5 squares.
3. Remove 6 matchsticks to make 3 squares.
4. Remove 8 matchsticks to make 4 squares.
5. Remove 8 matchsticks to make 3 squares.
6. Remove 8 matchsticks to make 2 squares.

Challenges:

1. Use all 24 matchsticks to make 4 squares.
2. Use all 24 matchsticks to make 5 squares.
3. Use all 24 matchsticks to make 6 squares.
4. Use all 24 matchsticks to make 7 squares.
5. Use all 24 matchsticks to make 8 squares.
6. Use all 24 matchsticks to make 9 squares.



Activity #5: Nim

Materials:

- 24 matchsticks

Objective:

Take the last matchstick.

Set-Up:

1. Place all of the matchsticks in a pile on a flat surface.

Rules:

1. Players take turns taking 1, 2, or 3 matchsticks.
2. The player who takes the last matchstick *wins*!

Variants:

1. Play the same game with a different number of matchsticks in the starting pile.
2. Play the same game, but allow players to take a different number of matchsticks each turn (e.g. 1, 2, 3, or 4; 2, 3, or 4; 1, 3, or 5).
3. Play the same game, but the player who takes the last matchstick *loses*.
4. Play the same game, but players take turns taking up to half of the available matchsticks. Players must take at least 1 matchstick, even if it breaks the previous rule.
5. Play the same game, but players take turns taking up to twice as many as the previous player. Players must take at least 1 matchstick. The first player must take 1 matchstick.
6. Play the same game, but start with an odd number of matchsticks. The player who has an odd number of matchsticks by the end of the game *wins*.



Activity #6: Continuous Dots and Boxes

Materials:

- 24 matchsticks
- 10 two-color counters

Objective:

Create the most squares.

Set-Up:

1. Find a large flat surface, like a table. Other than that, there is no setup!

Rules:

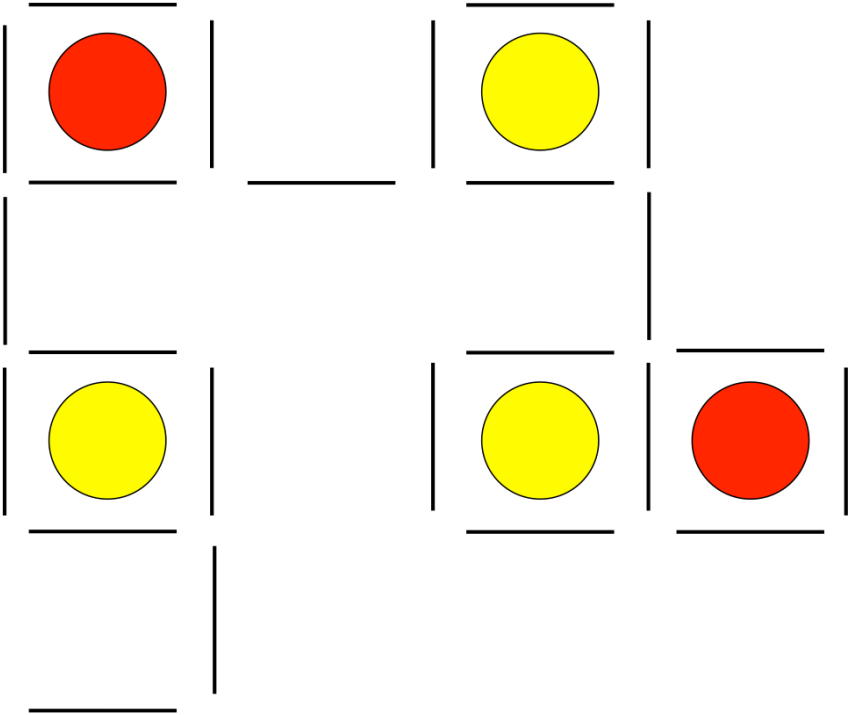
1. Each player starts with 12 matchsticks and 5 two-color counters. One person plays with red counters and the other with yellow.
2. Players take turns placing matchsticks horizontally or vertically on the playing surface.
3. When a new matchstick is placed, it must touch a matchstick that is already on the playing surface.
4. There can be no more than 3 matchsticks in a straight line.
5. When a player completes a square, the player places one of his or her two-color counters inside their square to claim it.
6. When both players run out of matchsticks, the player who completes and claims the most squares wins!

Variants:

1. Play the same game, but add the rule that when a player completes a square, the player gets another turn.
2. Play the same game, but the player who completes the most number of squares loses. Add the rule that if a player can complete a square, they must complete a square.



Example of a Completed Continuous Dots and Boxes Game



Yellow Wins!



Activity #7: The Game of the Amazons

Materials:

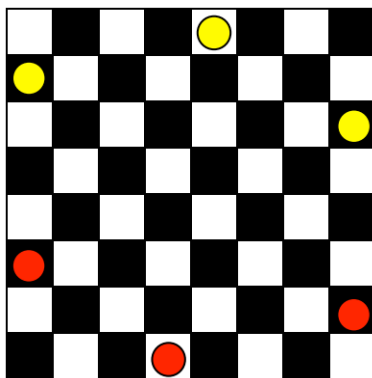
- 6 two-color counters
- 24 matchsticks
- Chessboard

Objective:

Trap all of the other player's amazons.

Set-Up:

1. One player chooses red, and one chooses yellow.
2. Each player gets 3 amazons in his or her color and places them on a chessboard, like below:



3. Place a pile of matchsticks on one side of the board.

Rules:

1. Players take turns moving one of their amazons.
2. Amazons move like queens (any number of squares up, down, left, right, or diagonal).
3. Amazons cannot land on or jump over other amazons.
4. After a player moves an amazon, that amazon shoots a flaming arrow from the square on which the amazon lands.
5. The player chooses the square on which the flaming arrow lands. A flaming arrow also moves like a queen (any number of squares up, down, left, right, or diagonal).
6. The square on which a flaming arrow lands on is destroyed for the rest of the game. Place a matchstick on destroyed squares.
7. Amazons cannot land on or jump over destroyed squares.
8. When a player can no longer move any of his or her amazons, the player loses.

Variants:

1. Play the same game, but place your amazons in different starting squares.
2. Play the same game, but start with more or fewer amazons.
3. Play the same game, but an amazon shoots two flaming arrows each turn instead of one.
4. Play the same game, but allow amazons to land on and capture enemy amazons.
5. Play the same game, but amazons now move like knights (L-shape) instead of queens.



Activity #8: Rook's Move

Materials:

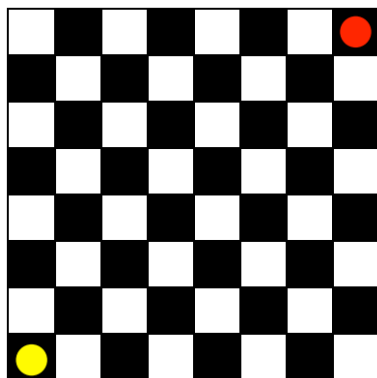
- 2 two-color counters
- Chessboard

Objective:

Move the playing piece (red) onto the goal square (yellow).

Set-Up:

1. Place a red counter in the upper right-hand corner of a chessboard. Place a yellow counter in the lower left-hand corner, like below:



Rules:

1. Players take turns moving the red counter.
2. The red counter moves like a rook towards the yellow counter (any number of squares to the left or downward).
3. The first player to reach the yellow counter wins.

Variants:

1. Play the same game, but have the red counter start on another square on the chessboard.
2. Play the same game, but the first player to reach the yellow counter loses.
3. Play the same game, but the red counter moves like a king towards the yellow counter (one square to the left, downward, or diagonally southwest).
4. Play the same game, but the red counter moves like a knight towards the yellow counter (southwest L-shapes). If a player cannot move the red counter in a southwest L-shape, the player may move the red counter in any L-shape. A player cannot force the other player to return to the same square two times in a row.



Activity #9: Angels and Devils

Materials:

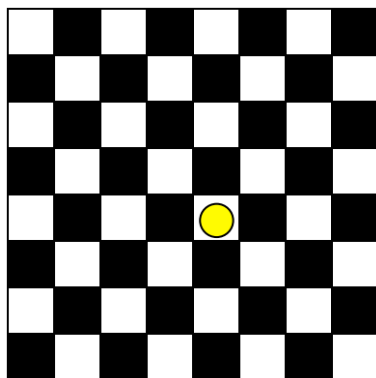
- 1 two-color counter
- 24 matchsticks
- Chessboard

Objective:

The Angel wins if she reaches any edge of the board. The Devil wins if she traps the Angel.

Set-Up:

1. One player chooses to be the Angel, and the other the Devil.
2. The Angel places a two-color counter (it doesn't matter if it's red or yellow) in one of the middle four squares on the chessboard, like below:



3. The Devil places the matchsticks in a pile next to the chessboard.

Rules:

1. The Devil goes first. The Devil destroys one of the empty squares on the board by placing a matchstick over it.
2. The Angel goes next. The Angel moves one square up, down, left or right.
3. The Angel cannot move diagonally.
4. The Angel cannot land on or jump over any destroyed square.
5. The Devil and Angel alternate turns until either the Angel escapes to one edge of the board or the Devil traps the Angel.

Variants:

1. Play the same game, but the Angel goes first.
2. Play the same game, but the Angel can only move one square diagonally.
3. Play the same game, but the Angel moves like a king (one square up, down, left, right, or diagonally).
4. Play the same game, but the Angel moves like a king, and the Devil destroys 2 squares each turn instead of 1.
5. Play the same game, but the Angel moves two squares up, down, left, right, or diagonally, and the Devil destroys a number of squares each turn that is agreed upon by the players before the game starts.



References

Many different sources and organizations have inspired the puzzles and games found in this booklet. I wanted to give credit to my many inspirations as well as provide you all with some avenues to further explore the world of recreational math.

1. Budapest Semesters in Mathematics Education
[\[bsmeducation.com\]](http://bsmeducation.com) (Game #1, Game #3, Game #8)
2. The Moscow Puzzles: 359 Mathematical Recreations by Boris A. Kordemsky (Puzzle #2)
3. Tricks, Games, and Puzzles with Matches by Maxey Brooke (Puzzle #4, Game #5)
4. Julia Robinson Math Festivals [\[jrmf.org\]](http://jrmf.org) (Game #7, Game #8)
5. Winning Ways for your Mathematical Plays by Burlekamp, Conway, and Guy (Game #9)

“The JRMF really gets it right. Usually the best parts of mathematics are kept away from the public, as if you needed to be a mathematician to get to the fun stuff! It’s refreshing to see a festival that brings this stuff to light, and in such a relaxed atmosphere. If you’re lucky enough to have a JRMF near you, don’t miss it! It’s the best math party around.”

Vi Hart, Mathemusician, youtube.com/user/ViHart

Julia Robinson Mathematics Festival supports locally organized events that inspire K–12 students to explore the richness and beauty of mathematics through collaborative, creative problem-solving.

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