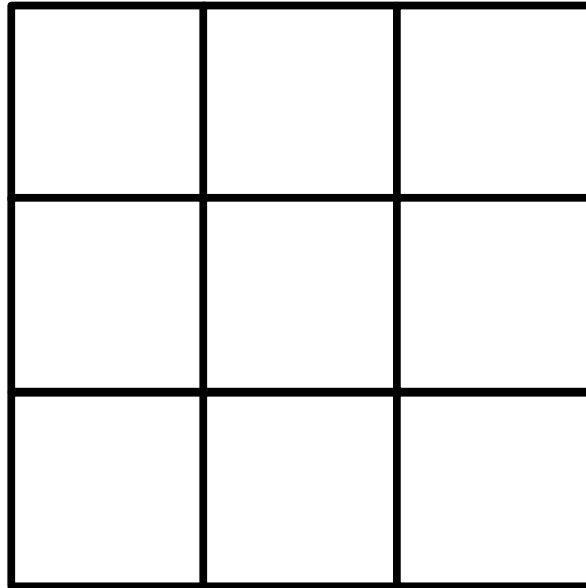


## Standard Tic-Tac-Toe



Use the cutout X and O to play a few games of Tic-Tac-Toe. While you are playing, think about the following questions:

1. Is there a way for the first player (X) to guarantee a win or tie?
2. Is there a way for the second player (O) to guarantee a win or tie?

# Torus Tic-Tac-Toe

To get use to playing Torus Tic-Tac-Toe, play on the attached numbered board. Here are the rules:

1. The first player picks a number. The player places an X on each instance where the number appears. (Example: If the first player picks 1, place an X on each 1 on the board)
2. Player two picks another number. The player places an O on each instance where the number appears.
3. Players continue picking a new number and placing their symbols (X or O) until a player gets 3 X or 3 O in a row. (Horizontal, Vertical, or Diagonal)

Play a few games of Torus Tic-Tac-Toe. While you are playing, try to answer the following questions:

3. Is there a way for the first player (X) to guarantee a win or tie?
4. Is there a way for the second player (O) to guarantee a win or tie?
5. Does it matter where the 1<sup>st</sup> player (X) places their X?

Next, try playing on the gluing diagram handouts. Do the following:

1. Try to mark four different ways to get three of a single symbol in a row on the gluing diagram board that do not work in the standard game.
2. Play a few games to get use to playing on a gluing diagram.

# Torus

			1	2	3			
			4	5	6			
			7	8	9			
1	2	3	1	2	3	1	2	3
4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9
			1	2	3			
			4	5	6			
			7	8	9			



# Klein Bottle Tic-Tac-Toe

Play a few games of Klein Bottle Tic-Tac-Toe. The rules are similar to the torus version.

While you are playing, try to answer the following questions:

1. Is there a way for the first player (X) to guarantee a win or tie?
2. Is there a way for the second player (O) to guarantee a win or tie?
3. Does it matter where the 1<sup>st</sup> player (X) places their X?

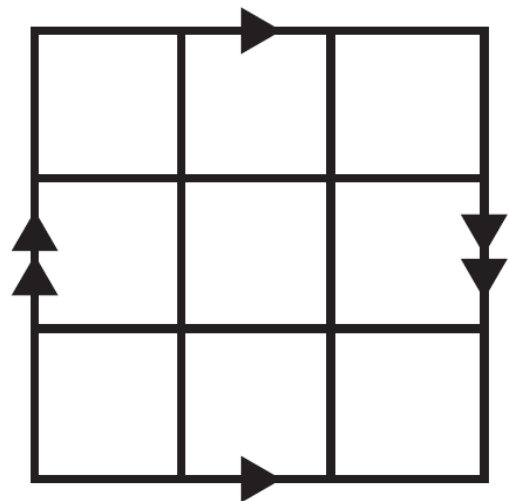
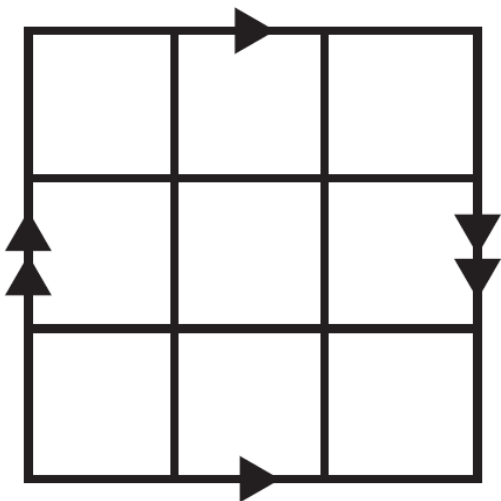
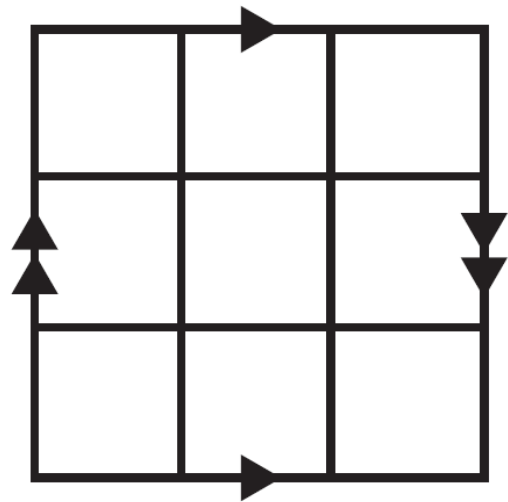
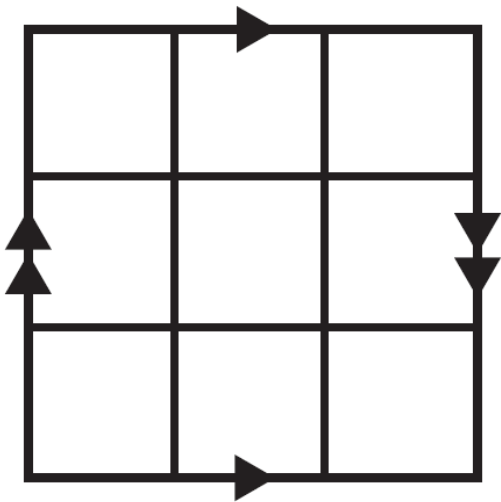
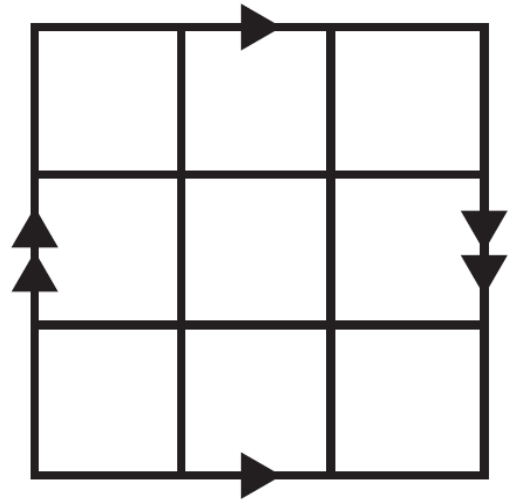
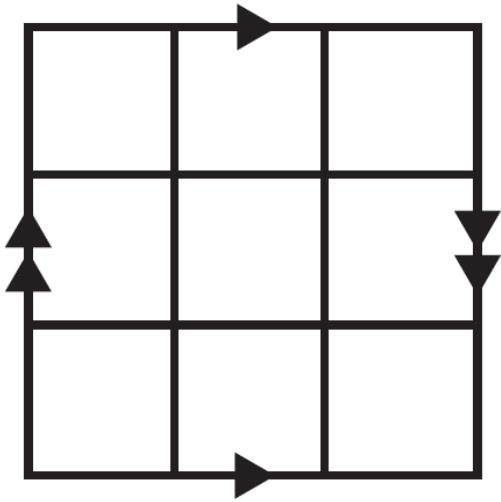
Next, try playing on the gluing diagram handouts. Do the following:

1. Try to mark four different ways to get three of a single symbol in a row on the gluing diagram board that do not work in the standard and torus games.
2. Play a few games to get use to playing on a gluing diagram.

# Klein Bottle

			1	2	3			
			4	5	6			
			7	8	9			
7	8	9	1	2	3	7	8	9
4	5	6	4	5	6	4	5	6
1	2	3	7	8	9	1	2	3
			1	2	3			
			4	5	6			
			7	8	9			

# Tic-Tac-Toe on a Klein Bottle



# Projective Plane Tic-Tac-Toe

Play a few games of Projective Plane Tic-Tac-Toe. The rules are similar to the torus version.

While you are playing, try to answer the following questions:

1. Is there a way for the first player (X) to guarantee a win or tie?
2. Is there a way for the second player (O) to guarantee a win or tie?
3. Does it matter where the 1<sup>st</sup> player (X) places their X?

Next, try playing on the gluing diagram handouts. Do the following:

1. Try to mark four different ways to get three of a single symbol in a row on the gluing diagram board that do not work in the previous versions of the game.
2. Play a few games to get use to playing on a gluing diagram.



# Projective Plane

			3	2	1			
			6	5	4			
			9	8	7			
7	8	9	1	2	3	7	8	9
4	5	6	4	5	6	4	5	6
1	2	3	7	8	9	1	2	3
			3	2	1			
			6	5	4			
			9	8	7			

# Tic-Tac-Toe on a Projective Plane

