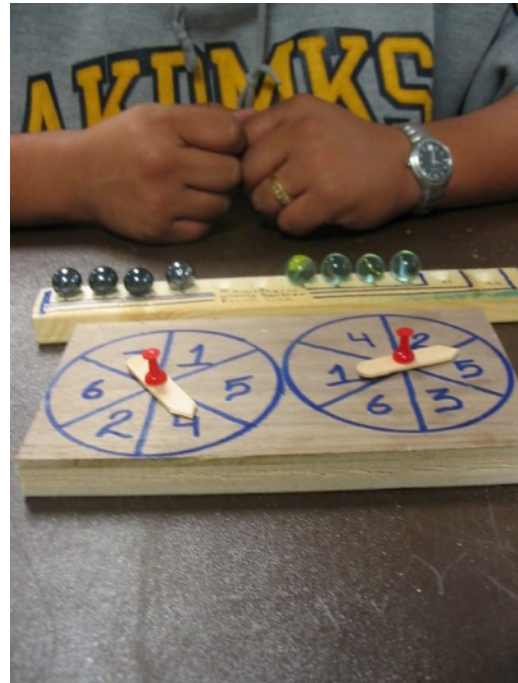


Games of Chance and Brains

Sometimes you get lucky; sometimes you get smart.

Parts:

	Wood base for spinner
	1 x 2 for marbles, at least 10" long
2	Popsicle sticks
2	Washers, #6
2	Pushpins
	Cups for circles
	Template for holes
8	Marbles, cat eye
4	Marbles, solid
	Small bags for marbles



Extra Tools:

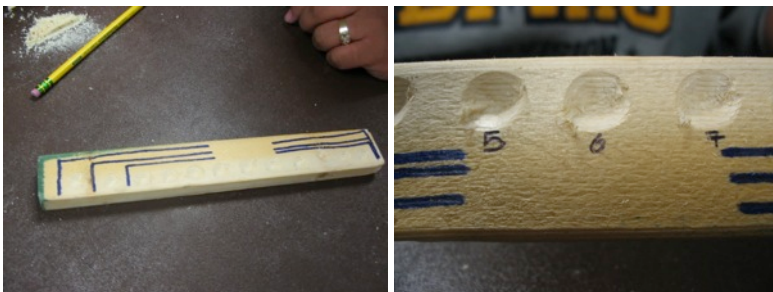
Drill
Drill platform
Large drill bit, around ½"
Nail bit, small
Clamps
Wood saws
Markers

How To Build:

Cut at least 10" of 1x2 piece of wood. Mark the wood 12 times at $\frac{3}{4}$ " intervals. Drill 12 divots with a large bit.



Number the holes from 1-12. Mark 3 different sections. The first section is from 1-10 called Switcheroo. The second is 1-11 called the Gambler. The third is from 1-12 called Finish Line.



Switcheroo

Place four marbles on holes 1 through 4, and four on holes 7 through 10. The goal is to change the marbles' places (right four to the left, left four to the right). There are two rules. #1: You can only move a marble forward one hole, or jump a single marble. #2: You can't move backward.



(Don't read hints until you've tried it for a while!)

Hint #1: In the middle of the board, you should always keep the pattern XOXOXO. If you ever get two together - XXXOXO - you have made an error. An error is shown here.

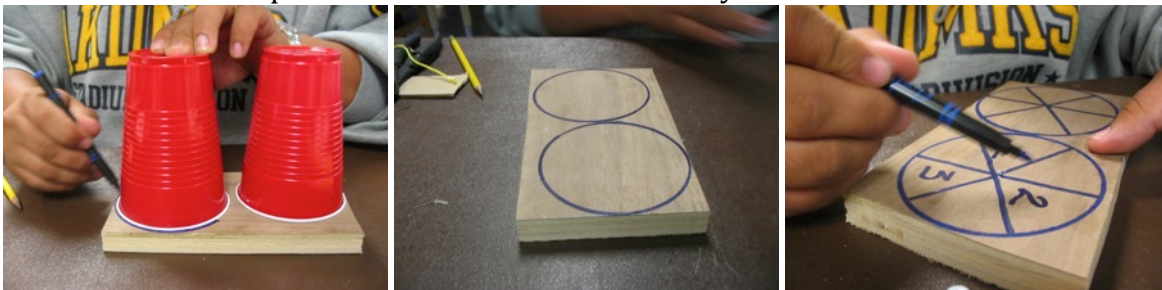


Hint #2: Keep moving all the marbles toward the center. You can't just focus on a few. All the marbles are necessary because they all have to jump one another. First move all of one color that are possible, then all of the other color that are possible, then repeat. Shown here is a good arrangement to have mid-game.



Spinners

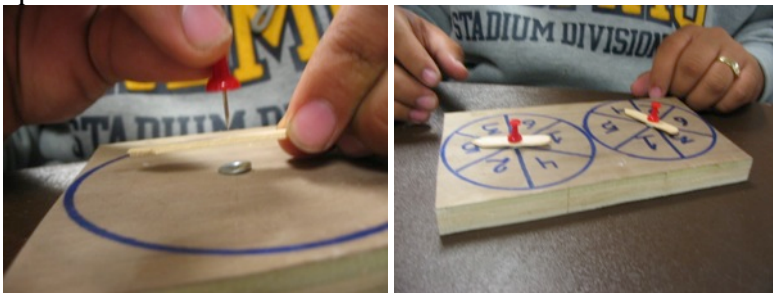
Draw 2 circles on a piece of wood. Divide them evenly into 6 sections.



Cut a Popsicle stick in 2 pieces. Cut points on the two pieces. Use a nail bit to make holes in the center of the two pieces. Push slowly or the pieces will split. These are the spinners.



Stick the spinners to the center of each circle using pushpins. Put a washer under each one to make it spin better.



Gambler

Use 11 holes for this game. Flick both spinners. Add up the two numbers. Place marbles in any two holes that add up to that number. For example, if your spinners land on 2 and 6, you can put one marble on hole 8, or one marble on hole 7 plus one on hole 1, or one on hole 6 and one on hole 2, or one on hole 3 and one on hole 5.

Flick the spinners again and do it again. Continue until you reach a number that, no matter how you divide it, you can't put it on the board because the holes are already full. Your score is the number of marbles you have in holes. You can play yourself or challenge others.

Finish Line

Use all 12 holes for this game. Compete against one or more persons, taking turns. Flick both spinners and try to make a 1. You can add, subtract, multiply or divide. If one spinner lands right on the number you need, you can also take it.

For example, a 1 can be made by one spinner landing on a 1, or by landing on a 3 and a 2 ($3-2=1$), or both spinners landing on the same number ($4/4=1$). After you get a 1, you try to make a 2, and so on until you get to 12, the finish line. If you are able to put down a marble, you may spin again.

Concepts:

- Switcheroo: two simple rules make a complicated game.
- Gambler: the higher numbers are harder to make; the low numbers are always possible.
- Finish Line: there are a lot of ways to make a single number.

Focus Questions:

What is the key to winning Switcheroo?

What is the key to winning Gambler?

What is the key to winning Finish Line?

Why do you think we used spinners and not dice?

Elaboration:

These three games all involve math. To win Switcheroo, you have to look at patterns and think about the whole game board all the time. Because you can only jump one marble of a different color, you can never have two marbles of the same color beside each other. The two empty spaces in the center at the beginning give you one chance to mess up. Once you can win it consistently, try it with only nine holes.

Most gambling is based on probability. When you flick the spinners in Gambler, each has more or less the same chance of falling on any number. But because you can add then separate again, there are many ways to get the small numbers. For example, any spin can result in a 1 plus something else. However, there is only one way to get 11 (5 and 6) and only two ways to get 10 (5 and 5 or 6 and 4). When one of these comes up, you'd better take it. Winning depends on luck, but it also depends on you leaving open numbers with the best possibility of appearing again.

Finish Line is practice at arithmetic together with luck. Every number from 1 to 12 can be made in at least two ways except 11. Each contestant has the same numbers to fill, so everyone has the same chance, but if you don't think about all the possible operations, you may miss an opportunity.

For continued exploration with the two spinner games, write out all the possibilities. Gambler would generate a list like this:

Number	Possibilities	Number of possibilities
1	Impossible	0
2	2	1
3	3, 1 and 2	2
4	4, 1 and 3,	2
5	5, 1 and 4, 2 and 3	3
6	6, 1 and 5, 2 and 4	3
7		
Etc. all the way to 11		

You can also count how many times a given number appears. For example, in the partial table above, "1" appears four times, "5" appears twice, "6" appears only once. The more often a number appears, the

more chance you'll be able to use it if it comes up again. You could graph the results with the numbers 1 through 6 along the horizontal axis and the number of times they appear on the vertical axis.

Finish Line would generate a list like this:

Number	How to make it	Number of ways to make it
1	$1 \div 1$, $2 \div 2$, $3 \div 3$, $4 \div 4$, $5 \div 5$, $6 \div 6$, $2-1$, $3-2$, $4-3$, $5-4$, $6-5$,	Eleven ways
2	$1+1$, $3-1$, $4-2$, $5-3$, $6-4$, $2 \div 1$, $4 \div 2$, $6 \div 3$, 2×1	Nine ways
3	$1+2$, $4-1$, $5-2$, $6-3$, $6 \div 2$, 3×1	Six ways
4		
Etc. all the way to 12		

These results can also be graphed.

Building these games is part of the fun, but you can still play them without such a fancy set up.

Switcheroo can be played with eight pennies - four heads and four tails – on a marked paper. The other two can be played using dice and pennies on paper. Dice are hard to make from wood. If any side is smaller than the others, that side has a lower probability of landing down. It is easy to make hollow dice from a piece of thick paper though.

Links to k-12 California Content Standards:

Grades k-8 Standard Set Investigation and Experimentation

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other strands, students should develop their own questions and perform investigations.

Grades k-12 Mathematical Reasoning:

1.0 Students make decisions about how to approach problems:

1.1 Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

1.2 Determine when and how to break a problem into simpler parts.

2.0 Students use strategies, skills, and concepts in finding solutions:

2.1 Use estimation to verify the reasonableness of calculated results.

2.2 Apply strategies and results from simpler problems to more complex problems.

2.3 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and

models, to explain mathematical reasoning.

2.5 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.0 Students move beyond a particular problem by generalizing to other situations:

3.1 Evaluate the reasonableness of the solution in the context of the original situation.

3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.

3.3 Develop generalizations of the results obtained and apply them in other circumstances.