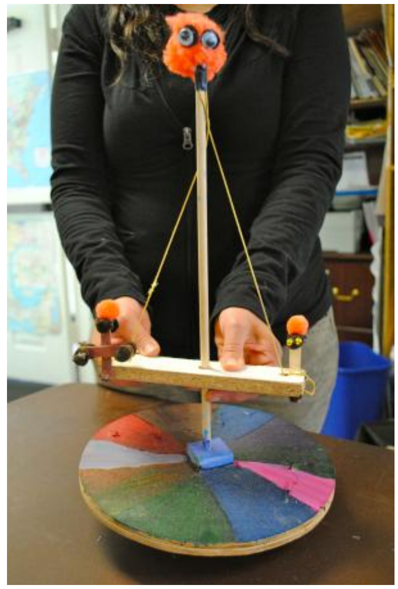
Carousel Pump

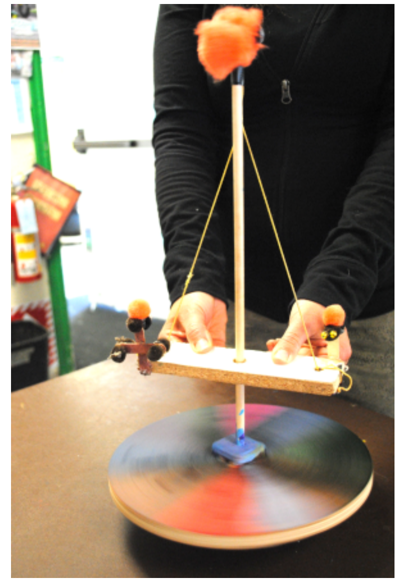
Category: Physics: Force & Motion,
Balance & Center of Mass

Type: Make & Take

Rough Parts List:

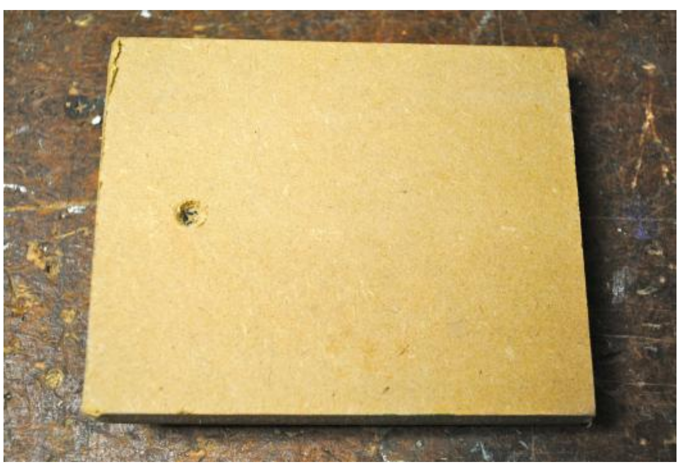
1	Wooden baseboard
24”	Dowel, 5/16”
1	String, medium
1	1x2” wood piece
1	Nail
	Paint, markers, & decorations
	Drill
	File or sandpaper





Video: http://youtu.be/Q9csA2b9nXw

How To:



Cut a baseboard into any shape.

With the head of a small nail, find the center of gravity of the baseboard.

Drill a 19/64ths hole through the center of the baseboard.

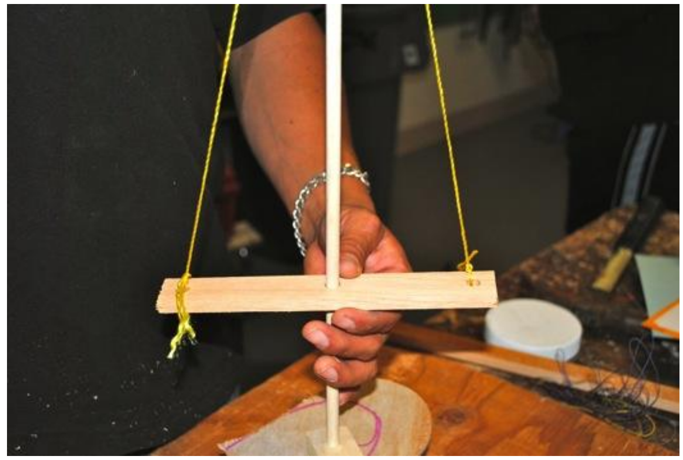
Sharpen the tip of a dowel.

File the tip of the dowel to a dull point.

Insert the dowel through the baseboard with the tip pointing down.

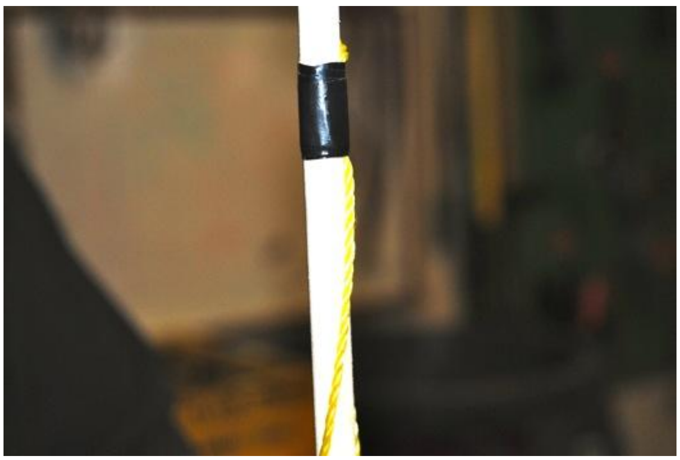
Drill a hole at each end of the rectangular block of wood.

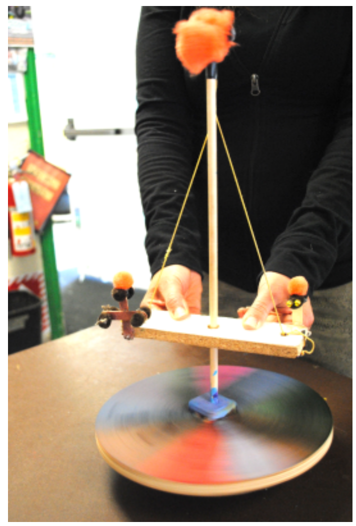
Drill a hole that is wider than the dowel in the center of the block.



Fold a piece of string in half
and attach each end to 1 hole.

Insert the dowel through the center hole.





Loop the string over the top of the dowel and
tape it in place.

Decorate the carousel.
Pump the rectangular piece of wood up and
down to spin the carousel

Fine Points:

→ The string must be exactly the same length on both sides.
→ The hole in the baseboard must be bigger than the dowel so that the dowel can easily slide through it.
→ The bottom of the dowel should be filed to a round (not sharp!) edge.
→ It is very important drill the hole exactly through the center of mass of the carousel. If you miss it, the carousel will wobble.

Concepts Involved:

- Momentum
- Angular motion converted to and from linear motion
- Cyclic motion

Focus Questions:

1. Think of a practical use for a Pumping Carousel.

2. The pump system on this project is one of the ways people have made fire. The tip of the shaft is rubbing very hard on the hole it is sitting in, so it gets quite hot. This system changes direction on each stroke. Do you think it would work better if it only went in one direction? Why or why not?
3. Why do you think tops and carousels are usually round?
4. How would your project work differently if you made the shaft twice as long?

Elaboration:

There are many ways to convert linear motion to angular motion. Cars and bikes do this by putting the edge of the rotating wheels in contact with the ground. Cams do this by using an offset wheel to push up on another piece. Tops do this by wrapping a string around a shaft and pulling. This project also uses a string wrapped a shaft but instead of pulling, we'll be pushing. The carousel will also change directions as the string winds and unwinds.

Once the carousel is spinning rapidly in one directly, you may let go and watch it spin. This is angular momentum at work. Isaac Newton said things in motion tend to stay in motion, until acted on by an outside force. This is true for things traveling in a straight line and also spinning things. The outside forces on this carousel are the same as those affecting a top: air friction and friction with the tip on the ground. Both of these are pretty small, so it may be able to go a long time if it is well balanced.

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.

Grade 2 Standard Set 1. Physical Sciences:

The motion of objects can be observed and measured.

1.c Students know the way to change how something is moving is by giving it a push or a pull. The size of the change is related to the strength, or the amount of force, of the push or pull.

1.d Students know tools and machines are used to apply pushes and pulls (forces) to make things move.

Grade 3 Standard Set 1. Physical Sciences (Energy & Matter)
1.c Students know machines and living things convert stored energy to motion and heat.

Grade 8 Standard Set 2. Forces:
Unbalanced forces cause changes in velocity.
2.a Students know a force has both direction and magnitude.
2.c Students know when the forces on an object are balanced, the motion of the object does not change.
2.e Students know that when the forces on an object are unbalanced, the object will change its velocity (that is, it will speed up, slow down, or change direction).

Grade 9-12 Physics Standard Set 1. Motion & Forces
Newton's laws predict the motion of most objects.
1.b Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's First Law).