611-0205 (40-226) Rotating Platform

Safety Note: Do not exceed 220 pounds on platform!

Warranty and Parts:

We replace all missing or defective items free of charge. For additional parts, we accept Mastercard, Visa and School P.O's. All products are warranted to be free from defect for 90 days. Does not include accident, misuse or normal wear and tear.

Rolling Friction

Additional Materials Needed:

- **Spring scale**
- **6 foot length of string**

Rolling friction opposes the rolling of a round object over a solid surface. It is less than sliding friction when the weight to be moved is the same and when the materials in contact are hard. Rolling friction occurs when a marble is rolled over a thick rug. The marble must push down the rug fibers in order to move. When riding a bicycle, the flattening of the tires on the pavement causes friction. On a larger scale, the ancient Egyptians used round logs to move stone blocks and giant statues.

To compute rolling friction using the Rotating Platform, locate the 14 steel balls between the two steel plates by examining the side of the apparatus. The distance between the two balls should be about 200 mm - determine with a ruler. From this measure (the diameter of the device), locate the radius of the distance on which they turn.

How to Operate:

Set the rotating platform on a level surface such as a table or floor. (For safety reasons, do not use a chair or stool). Attach a spring scale and use it to measure the starting and rolling friction. *This can be done in the following fashion.*

1. Tie your spring scale to one end of a long string, up to 6 feet in length.
2. Tack the other end of the string to the edge of the disc by means of the push pin that is attached to the periphery of the disc.
3. Wrap the string, with the spring scale on its free end, around the disc edge. The string must be long enough to go around the edge of your disc at least halfway. Holding the spring scale, position the string so that it is on the same plane with the disc and parallel to the square base.
4. When the platform is at rest, slowly and gently pull on the spring scale. Make note of the force required to start the apparatus rolling. This force is the **starting friction.**
5. As the platform rolls, apply just enough force to keep the platform moving. This is the **rolling friction.**
6. Use these values to calculate two kinds of friction: **Static** and **dynamic.**
7. Repeat using masses of various sizes up to 100 kg (220 lbs). We recommend the use of **books, bricks** or **sand bags** for this purpose. Weigh each object to within 1% of your expected final weight. Place the masses in the center of the disc.

Your data should include:

1. Radius of rotation of your ball bearings (5 mm steel balls)
2. Radius of the action of force exerted through your spring scale
3. Spring scale readings (2 for each mass) - take the average as your data
4. Total mass on Rotating Platform

Graph your data as follows:

1. Use the total mass on the rotating platform as your X ordinate.
2. Use the average spring scale reading as the Y ordinate.
3. Compare each mass for each (two readings divided by 2) sparing scale reading and plot on the graph.
4. Draw a line through your plots to determine the slope. The slope of this line corresponds to the values for Force divided by Mass

$$K = \frac{F}{M}$$

Note, however, that this is the force applied at the periphery of the apparatus. Calculate what this value should be at the radius of rotation, for the rolling friction that is being studied emanates from the center of the disc. Determine the force applied by the total mass at the radius of rotation. Them combine the two forces - at the center and at the periphery - to arrive at the two distinct coefficients of friction, which is defined as:

$$\textbf{Coefficient of friction} = \frac{\textbf{Friction Force}}{\textbf{Mass}}$$

Questions:

- Is the coefficient of friction the same at small loads as at large loads?
- Would it be more accurate to calculate the coefficient of friction if the weight of the platform top were included in your data?
- From the data you have, can you obtain a value for the weight of the platform top, and if so, how?

Precession of a Gyroscope

Additional Materials Needed:

- **Bicycle Wheel Gyroscope**

1. Gyroscopic precession can be demonstrated using a volunteer and a bicycle wheel gyroscope. **For safety reasons, the Rotating Platform must be placed on the floor if your volunteer is to stand on it.**
2. Alternatively you may place the Rotating Platform on a stool and have your demonstrator sit on it. In this case, you may wish to sit on the square bottom of the base rather than the disc. The apparatus works equally well either side up.
3. Tilt the spinning wheel to precess.

Weather Demonstrations

Additional Materials Needed:

- **Large round dish pan**
- **Ice cubes** in cage or basket about 8" in diameter
- **Potassium Permanganate crystals**
- **Electric drill (for use as motor)**

*with small diameter rod placed in drill chuck and a piece of rubber tubing fitted snugly over the rod to serve as a drive pulley**

- **Cradle to hold drill**

1. Fill the dish pan to a depth of 6" with warm water (at a temperature of about 3° C).
2. Rotate platform using the electric drill as a motor. Fit the drill with rod and tubing as described above and hold it in place with a cradle or other support in such a way that the drill is elevated in a horizontal position with the drive pulley (rubber tubing) placed under the Rotating Platform.
3. Set the drill to turn the platform at a speed of about 60 R.P.M. (see *Diagram 1*). You may need to experiment to determine the best way to position the drill.
4. After several minutes of steady rotating, the rotation of the liquid comes in to equilibrium with the rotating container. After about 15 minutes of sustained rotation, add a speck of potassium permanganate crystals to the water. If the water was in equilibrium with the container, the permanganate color grows into a purple dot; if not, a streak appears.
4. Now add a basket or cage of ice cubes to the center of the platform to simulate the poles. When more permanganate is sprinkled over the ice, a cyclone pattern appears. A strong purple color at the bottom of the pan develops into a pattern similar to a weather front in which zones of clear water from the melting ice are bordered by colored water. This is the typical pattern of a cold front, in which cold air moving south from the arctic wedges under warm air, pushing the war air southward and westward.

Since the ice melts rapidly, observations are of short duration.

5. Because this experiment uses temperature differences to create density differences, you can also use **liquids of different density.** You can use fresh water for one liquid and salt water for another.

One of the liquids should be colored with food coloring in order to see the results.

6. Fill the pan with fresh water and then rotate until equilibrium is achieved; next, add the heavier liquid at the center. Patterns similar to those of a cold front result.
7. If the lighter liquid is introduced at the center, it will float on top of the first liquid and gradually make its way to the edge. Your results in this case will be less clear-cut.

Other materials can be used for drive motors. These include: can openers, gear motors, sewing machine motors or erector set motors. Belts and pulleys may be required to reduce the speed to a reasonable level. The rotating platform should be level and the speed of rotation steady.

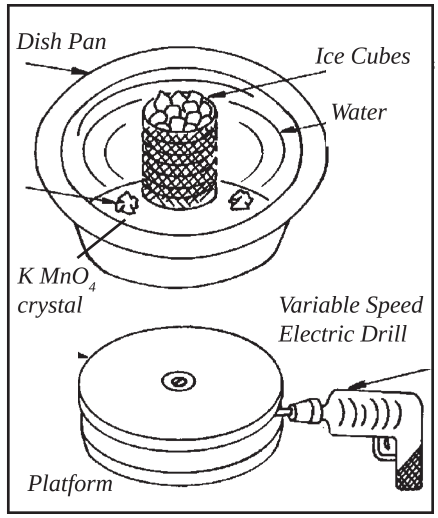

Diagram 1

Related Products:

611-1215 Ring and Disc - Simple materials with same mass and diameter-PVC ring and hardwood disc - demonstrate how mass is distributed in rolling bodies. Roll together down incline, study difference in acceleration.

611-1220 Variable Inertia - Instantly change distribution of mass with 8 balls inserted into your choice of compartments. Load each of two discs unevenly, roll together down an incline. Which is faster? Why? *Includes:* 8 steel balls, 2 discs, instructions.

611-0040 Halls Car - Use with inclined plane, pulley and weights to analyze link between work and energy. Nearly frictionless due to oil-free sleeve bearings. ABS plastic car has deep well for weights, wheels snap into place.

611-0350 Roman Arch - A working model of an architectural marvel - will even support your weight without glue or mortar. Build it without the template first. 23 precision cut hardwood blocks in 6 unique shapes, predrilled base and buttresses, hardware, instructions.

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