



An Inuit Yo-Yo

Sandra J. Walton

Topic

Centripetal force



Time

20 minutes



Safety

Please click on the safety icon to view the safety precautions. Allow enough space around you so that the toy does not hit anyone when in motion. Take care that the stoppers or corks used in the toy are tied securely.

Materials

one washer or nut

2-m string

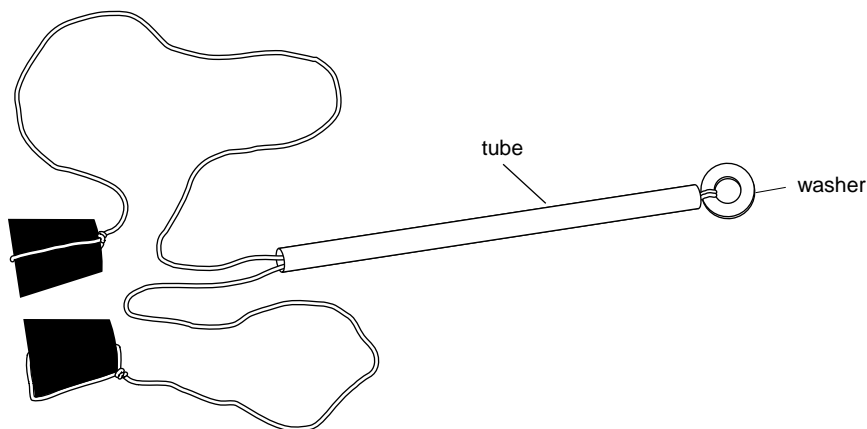
two large corks or two-holed stoppers

one unbreakable tube, about 1 cm in diameter and 10 cm in length (the tube of a ballpoint pen works well)

Procedure

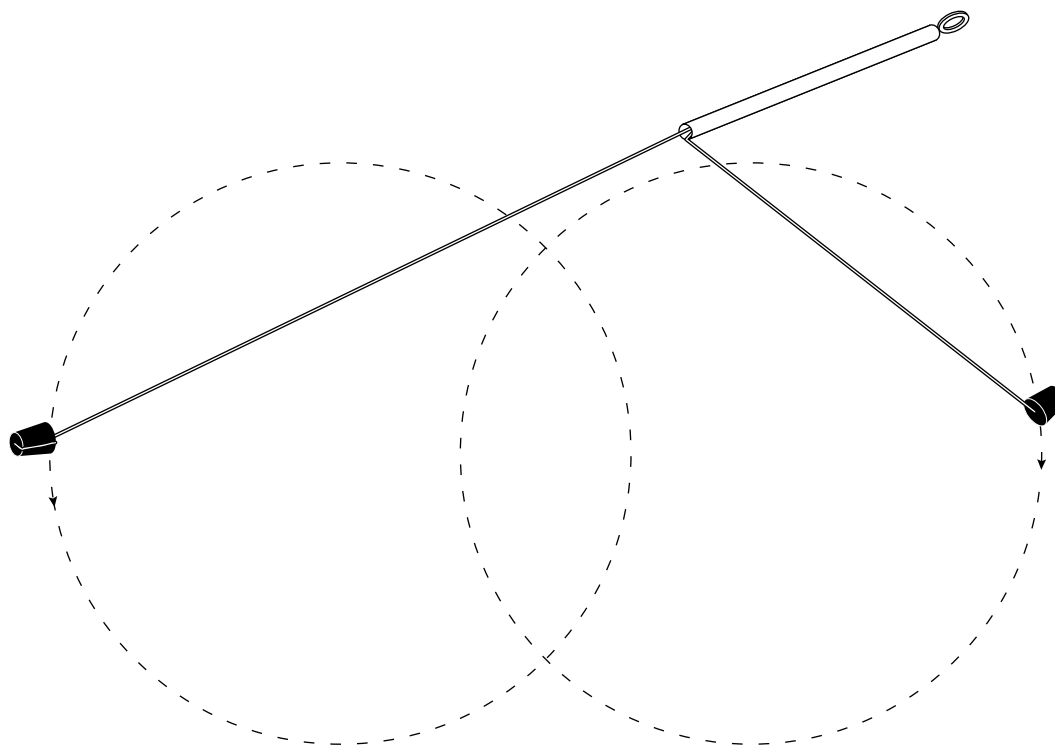
1. Cut the string into two pieces, one about 2 cm longer than the other. Tie one end of each string to the washer; feed the other end of each string through the tube, and tie on the corks or stoppers as shown in figure 1. Be sure that all knots are secure, and have an adult check the apparatus before you attempt to use it.

Figure 1



2. Hold the tube in one hand, with the washer end closer to your body. Hold one cork in your free hand and gently swing the other cork in circles. As the swinging cork is rising, release the other cork so that it is going down. Start “pumping” the tube up and down to get the corks moving in full circles of opposite direction (figure 2).

Figure 2



3. When the corks are rising, which way do you have to pump your hand?
4. When the corks are going down, which way do you have to pump your hand?
5. What do you call the force needed to keep the corks in circular motion, and in what direction is this force always exerted?

What's Going On

As the corks are rising, you pump your hand downward. As the corks are going down, you pump your hand upward. Centripetal force (center-seeking) keeps the corks in motion. Therefore, when the corks are moving up, you must exert a force downward, and vice versa.

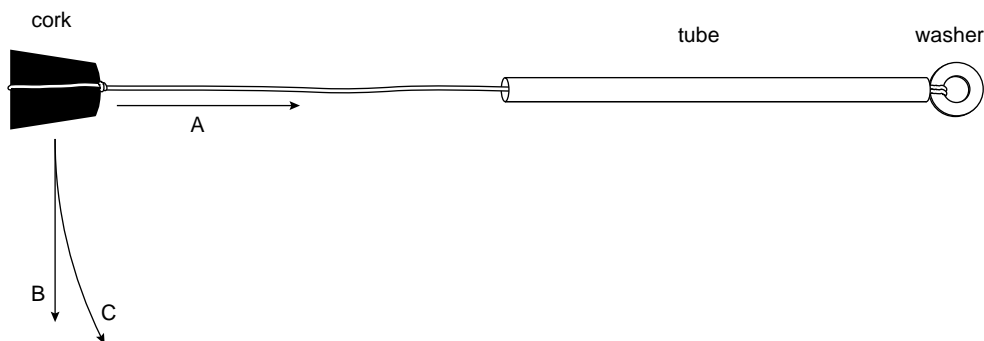
When you spin an object on a string, you exert centripetal force on the object by pulling in on the string (figure 3A). The object, however, has inertia, the tendency of a body to preserve its uniform motion in a straight line. Inertia allows the cork to fly in a straight line if the string were cut (figure 3B). The force exerted by pulling on the string causes it to veer off the inertial course and take a curved path through

space (figure 3C). Since any change of course is a kind of acceleration, and to accelerate something takes work, you feel that you are working to move the cork even though it is only going in circles. When you pump on the tube of the yo-yo, you shorten the string, which in turn pulls the cork in a smaller circle. Since the cork's course is changed more when traveling in a smaller circle, the cork accelerates more in the direction of its orbit, which is necessary when the cork is rising, because gravity pulls in the opposite direction of its orbit and decelerates it. The rhythmic pumping of the yo-yo acts to counteract gravity's deceleration force.

Connections

Centripetal force is the force that keeps objects moving in circles. In this demonstration, you learned about the properties of this force by using a little-known toy, an Inuit yo-yo.

Figure 3



Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES