Running in Circles

A new spin on the Coriolis effect

By Eric Muller

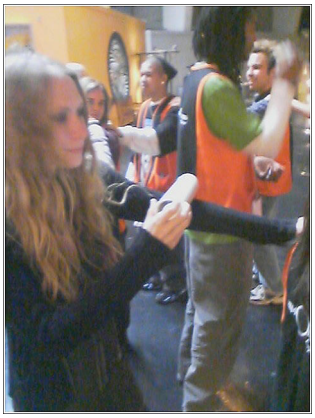
Use some common objects and a group of participants to understand a tough concept…the Coriolis effect.

Materials:

- Marbles or other small spherical objects
- Tubes (minimum 2 tubes)
  Tube diameter should be just a little larger than your marble and should be somewhere between 1 to 3 feet long (30cm to 1m long)
  Tubes can be made out of cardboard (like wrapping paper) or PVC
- At least 9 participants (to form a large diameter circle)
- Large space to run around

Assembly:

1. Have participants form a circle and have them place their hands on their neighbor's shoulder (this should help with keeping a constant spacing)
2. Station a participant in the center of the circle.
3. The central participant and at least one participant in the circle should have a tube and a marble.
4. The central participant should aim their tube at a single participant in the circle. The tube should be held in such a way that when all participants are standing still, a marble when inserted in the tube will roll down the tube and bounce its way towards and hit the outer participant (make sure this is done safely!).
5. A participant in the circle (preferably the one targeted by the central participant) should aim their tube at the central participant. This tube should be held in such a way that when all participants are standing still, a marble when inserted in the tube will roll down and bounce its way towards and hit the central participant (again, be mindful of safety).

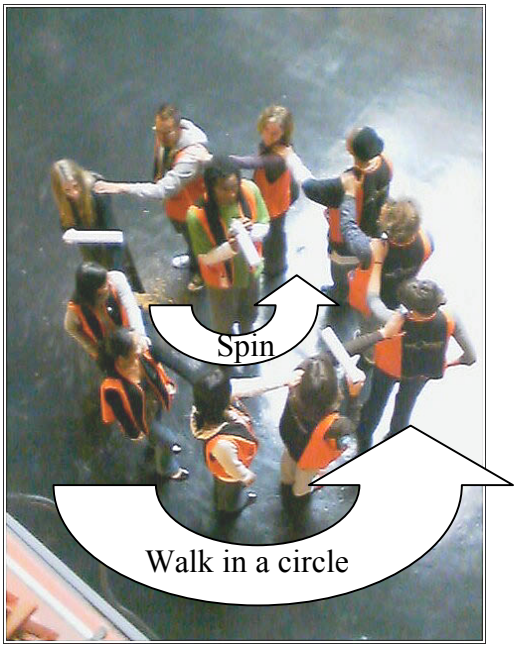


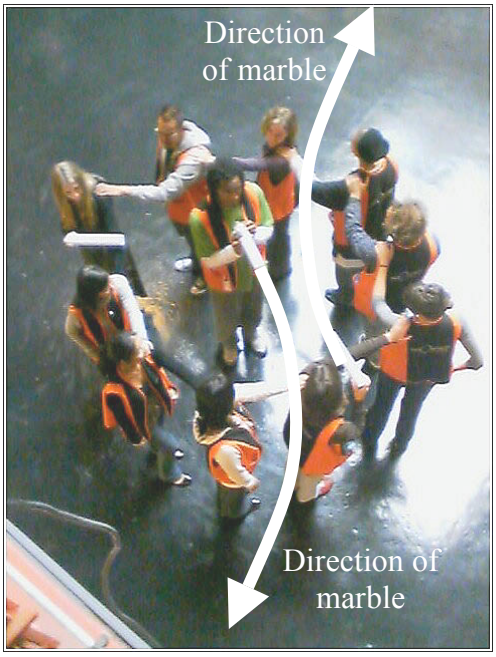
To do and notice:

1. Practice aiming your marbles. While all participants are standing still, have the participants (located centrally and on the circle) roll marbles at each other. If aimed and held correctly, the marbles should hit or at least come close to their intended target.
2. Have everyone start moving. The folks in the circle should walk in a circle about the central person. The central person should turn at the same rate as the circled folks walk. The central person should always

be aiming his/her tube at the same person in the circle and the participant in the circle should always be aiming his/her tube at the central person.

3. Make a prediction and do it:
    a. As everyone is moving, ask where will the central person's marble go after it is launched?
    b. Launch it!
    c. Were they correct?
4. Make a prediction and do it:
    a. As everyone is moving, ask where will the circling person's marble go after it is launched?
    b. Launch it!
    c. Were they correct?
5. Try this several times.
6. Try switching participants who launch the marble.
7. Try differing the group's speed.
8. Try changing the group's direction.





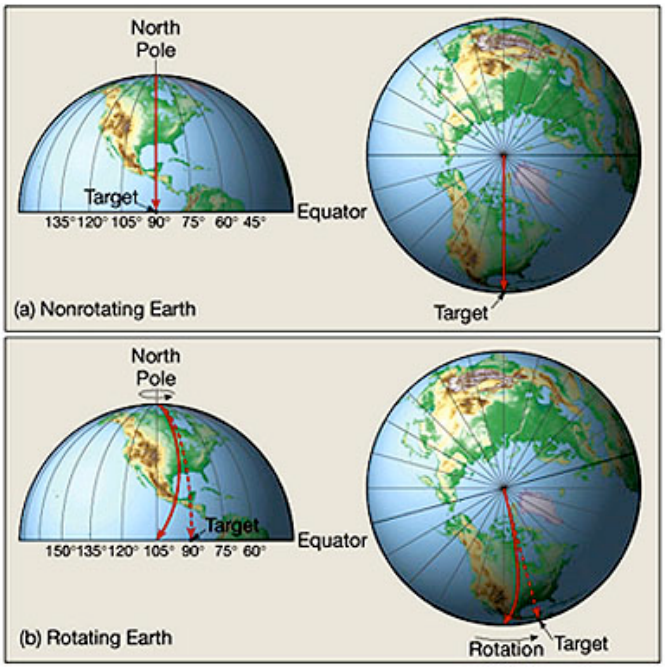
<u>What's going on?</u>
Did your marbles go where you thought when the group was moving? Often people guess the correct answer when shooting the ball from the center outwards. The marble seems to always go behind the targeted person. However, shooting the marble from the circling participant towards the center often surprises people. The marble seems deflect to the wrong side of the central person. It veers to the side that is in the direction of travel of the circling people.

This deflection of the marbles in this rotating reference frame is attributed to something called the Coriolis effect.

The central person is only slowly turning while trying to aim and shoot someone moving much faster on the circle. Therefore the marble shoots out straight from the tube, but doesn't have the correct velocity components to hit its target…it lags behind the person targeted. The opposite is true of the person trying to hit the central person from the faster moving circle. When released, th ball has faster velocity components that make it "over-shoot" the center target.

<u>So what?</u>
Instead of people walking around in circles, you can extend this model to the shape of a globe…such as the earth. In this

transformation, the central person is the pole of the globe and the people running around in a circle are on the equator.
In the case of a spinning globe, objects moving from a pole towards the outer circle of the equator tend to deflect or bend behind where they were originally headed. Oppositely, objects moving from the equator towards a pole tend to deflect or bend in front where they were originally headed.
The Coriolis effect can have large consequences for objects moving on a spinning globe. The Coriolis effect can affect everything from artillery shells and satellites to ocean currents and weather.



Options/Helpful hints:

1. Tying a string between the central person and his/her targeted person on the circle may help participants see how the marble is deflected. It also helps the group stay aligned and on pace for this activity.

2. Placing an additional person in the center to be the "gunner" helps with the task of launching the marble from the inside of the circle towards the outside. Likewise, having an additional person running around the outside of the circle (just next to the person on the circle whose supposed to launch the marble) might help in aiming and to launch the marble towards the center of the circle.

Other resources:
http://en.wikipedia.org/wiki/Coriolis_effect

Images of globe is from:
http://www.noaa.gov/features/resources/planet.html
http://rst.gsfc.nasa.gov/Sect14/Sect14_1c.html