Children's Discovery Museum of San Jose

# Secrets of Circles

## Teacher's Guide: Grade 2

## What's Going On?

The ***Secrets of Circles*** exhibition features 18 exhibits designed to inspire children and adults to ask questions and investigate the answers as they explore the math, science, and engineering of circles. Throughout the exhibit, children see examples of two- and three- dimensional circular forms and learn how circles aid engineers in solving problems. The activities described in this guide help children understand complex physics topics while playing with circles.

## Before You Visit

***Before You Visit CDM,*** experiment with different kinds of balls and explore the properties of spheres.

## During Your Visit

***During Your Visit to CDM,*** explore the exhibit.

## After Your Visit

***After Your Visit,*** use knowledge of circular forms and their movement to create toy cars.

## California Content Standards

**Grade 2:**

- English Language Arts: Reading – 2.3, 2.8
- Science – 1a, 1b, 1c, 1d, 1e, 4c

# Before You Visit
## Explore Balls

### What you'll need

**For each pair of students:**

- ❑ Large assortment of balls of different sizes, densities, and materials (ping pong balls, tennis balls, whiffle balls, squash balls, soft baby-toy balls, rubber playground balls, etc.)
- ❑ Clipboards or sturdy writing surface – 1 per pair of students
- ❑ Optional – chart paper or overhead transparencies
- ❑ Ramps
- ❑ Ramp-sized rectangles of various textured surfaces such as artificial turf, sand paper, satin, etc.
- ❑ Stopwatches
- ❑ Yard sticks, rulers, or tape measures

### Objective:

Observe and measure the motion of objects.

### What to Do:

1. This lesson works best if spread out over a number of days to allow sufficient time for exploration.
2. Tell children that they are going to think like scientists today. The first thing that scientists are good at is observing objects using their five senses. They will record their observations as they play with the balls.
3. Pair the children. Give each pair a clipboard and three different balls. Give the children plenty of time to manipulate the balls and record their observations.
4. Bring the class together to discuss their observations. Record their observations on chart paper, an overhead, or the board. When all observations have been recorded, reread what the class has discovered.
5. Take ideas from the class to determine an investigation question (Ideas: which ball rolls the farthest? Bounces the most? Bounces the highest?) Hopefully, these questions start coming up when recording the observations.
6. After determining an investigation question, lead the class to determine a measurable method for investigation and a way of recording the results. This step is a good stopping point, especially if additional materials need to be gathered for the investigation.
7. Record hypotheses from the children.
8. Allow time for children to complete the experiment as a whole class, individually, or in pairs.
9. Discuss the results and come to a conclusion.

### Assessment:

Ask children to explain the steps involved in thinking like a scientist (the scientific method).

### Extensions:

- Perform the same procedure with different round toys such as tops or hula hoops.
- Choose a different question for exploration.

# During Your Visit
## Guided Exploration of the Exhibit

### What you'll need:

- ❑ Hands, eyes, and brains

### The Gear Table:

- Do you think the gears will turn at the same rate? Which will be faster, the smaller ones or the larger ones? Do the number of teeth on a gear affect its turning speed? How do you know?
- Challenge children to predict and control the direction that the final gear in a chain will spin.

(Gears are circles with teeth that transmit energy from one object to the next. Using their teeth to connect them, the turning motion of one gear is transferred to another. By moving only one gear, children can move many others, limiting the amount of effort needed to move a large number of objects.)

### Inventing the Wheel:

- Which sled is easier to pull? Why?

(The lack of corners and points on a circle helps it to roll smoothly and to pull objects efficiently.)

### The Spinning Table:

- Do the balls move more quickly on the outer edge of the spinning table or in the middle?
- Can you make a ball change directions while it is spinning? How?
- What makes the balls easier to spin than the disks?

(Spheres will roll in any direction, but disks will only roll along their rounded edges. Balls and disks roll more quickly on the fast-moving outer edge of the table, while they roll more slowly and may even change direction as they cross the center of the table.)

### The Camera Taking Pictures:

- Can you create a picture with more than one circle? How?
- Can you find another way to create more than one picture?

(Children may use the small turntable on top of the larger one to create more circles and manipulate the speeds of the disks.)

# After Your Visit
## Making a Car

### What you'll need:

**For each child –**

- ❑ Toilet paper tube for the car's body
- ❑ 2 unsharpened pencils for the axles
- ❑ Glue
- ❑ Tape

**For the class –**

- ❑ A variety of materials from which to shape wheels – clay, thin sheets of rubber, craft foam, thin sheets of corkboard, florist foam, newspaper *(Note: You will need enough different materials for children to have a reasonable choice.)*
- ❑ One or two ramps: *You can create a ramp using a long piece of cardboard (maybe from a board game box top) and a stack of books or blocks.*

### Objective:

Children will use the discoveries they made at the Museum to design a car that travels down a ramp fast. They will use knowledge about the properties of circles and the ways that friction, weight, and density affect speed to design their cars.

### What to Do:

1. Lead children in a discussion about what they learned at the Museum. Start with circles. *For example: What makes a circle good for rolling? What is the difference between a sphere and a disk?*

   Next, talk about energy and motion. *For example: How do you make something move? By applying a force. If an object is placed at the top of the ramp, will you need to push it to make it go down? Gravity is a force pulling objects to the ground.*

2. Challenge children to design a car that will travel down the ramp the fastest.
3. Give children ample time to build their cars, test them on the ramps, and make changes. "Ample time" may mean more than one class session. It may also mean that after students are given time for initial exploration and trials, you bring the class back together to discuss their work, learn from each other, and provide some feedback from the teacher before proceeding with the building of their cars.
4. Test the relative speed of the cars by using stopwatches or holding races. It is important to consider how the cars are started – the initial force.

### Assessment:

Have each child explain how he or she made particular design choices. Note whether or not the choices reflect accurate knowledge about the physics of circles. *For example, did they choose a smooth sphere to limit friction? Did they weight the car to help gravity's pull? Did they decide to use a disk rather than a sphere so that their car could travel in a straight (and shorter) path?*

More important than the actual design of the car is how children explain why they built it in a particular manner.

### Extensions:

- Change the ramps in some way to change the amount of friction they provide, for example, by placing sandpaper, silky cloth, or Astroturf on top of them.
- Change the challenge. Ask children to design the slowest moving car or a car that travels the farthest (with or without the ramp).

Making a Car (continued) ☞

## Related CDM lesson plans:

- Wheels (Family Workshop)
- Tops (Family Workshop)

## Weblinks:

- www.learningscience.org/psc1bpositionmotionobjects.htm
- www.dreamsbeginhere.org/sanpablo/force_and_motion.htm
- http://sln.fi.edu/qa97/spotlight3/spotlight3.html
- www.learner.org/interactives/parkphysics/coaster/

## Additional reading (books for children):

- *What does a Wheel Do?*
  Aladdin Books
- *GO! The Whole World of Transportation*
  by Simone Bos, Phil Hunt, and Andrea Mills